Current Science

Vol. XVIII] AUGUST 1949 [No. 8

	Page
Role of Science in National Reconstruction	269
A Study of the Microtonal Variations in Frequencies in Karnatic Music—C. S. Ayyar	272
Indian Dairy Research Institute ..	274
Caustic Embrittlement of Boiler Plate and Rivet Steel—B. R. Nijhawan ..	275
Nature Conservation and National Parks ..	279
The Indian Chemical Society	282
Letters to the Editor	284
Dr. J. N. Mukherjee	307
Reviews	308
Some Methods of Purification and Industrially Important Reactions of p-Cymene—James Verghese	315
Science Notes and News	317

ROLE OF SCIENCE IN NATIONAL RECONSTRUCTION

THE Government of India has on the occasion of the second anniversary of the Independence Day, reviewed the position with respect to the establishment of 11 National Laboratories which are expected to play a vital role in the context of National reconstruction. The amount to be spent on construction and equipment of institutions intended to serve the needs of such a vast country as India—the total cost will be Rs. 3,80,50,000—is small compared with the large sums spent on research in countries like the U.S.A. and the United Kingdom.

These National Laboratories are being organised under the auspices of the Council of Scientific and Industrial Research. Each laboratory will cover all aspects of research in its respective field and will be equipped with semi-process or pilot-plant facilities for translating laboratory investigation into industrial practice.

The roles played by both fundamental and applied aspects of research have been fully recognised, and the laboratories are intended not merely to aid a particular industry with knowledge that is already available but also in the furtherance of such knowledge. Problems bearing on wider social aspects affecting the welfare of the community will also come within their purview, and they should be in a position to try alternative approaches to a problem simultaneously. It is not intended however that work of a kind ordinarily within the scope of research laboratories of industries or of Universities shall be undertaken.

National Physical Laboratory

Largest of the laboratories, the National Physical Laboratory is being located in Delhi. Its functions will be similar to those of the National Physical Laboratory in the U.K. and the Bureau of Standards, U.S.A. It will have eight divisions, dealing with weights and measures, applied mechanics and materials, heat and power, optics, elecricity, electronics and sound, hydraulics, and analytical chemistry. It is also proposed to attach a division of industrial physics, so that discoveries made at the laboratory may be worked out on a semi-commercial scale.

The Laboratory, the main wing of which is expected to be ready by the end of this month, is being built on a site of nearly 60 acres and is estimated to cover a total floor area of 220,000 sq. ft. Fully air-conditioned, it will be manned by more than 250 scientists and technicians.

National Chemical Laboratory

A special feature of the National Chemical Laboratory—under construction at Poona —will be the development of new processes up to the pilot-plant stage so that industry may be induced by the practical results obtained to adopt the processes developed for large-scale production. A pilot-plant for the manufacture of chemical cotton is at present being established.

This Laboratory will have seven main divisions, devoted to inorganic chemistry, physical chemistry, chemistry of high polymers, organic chemistry, bio-chemistry, chemical engineering, and survey and intelligence. The staff will consist of about 150 scientists.

National Metallurgical Laboratory

To be established at Jamshedpur, the Metallurgical Laboratory will cover a total working area of 63,000 sq. ft. and its staff will include more than 100 scientists. Besides metallurgical research, it will undertake research on ores, minerals and refractories as applied to metallurgy. A noteworthy feature will be the Laboratory's collaboration with Tata's, and already one result of this collaboration is a scheme for the substitution of manganese for nickel in austinitic steels. Specialists from the Laboratory will also be sent out to render technical advice to industrial firms in respect of other metallurgical operations.

Fuel Research Institute

Research already under way at the Fuel Research Institute, being built at Digwadih, in the Jharia coalfields, is of considerable importance to India's industrial development, and the results obtained so far on blending of coal for coking, and washing of coal have evoked wide interest. The Government of India recently appointed a committee, under the chairmanship of Dr. M. S. Krishnan, to advise on the adoption of these results on a large scale.

The Fuel Research Institute, which will undertake work in connection with Government's plans for production of synthetic liquid fuel, low temperature carbonisation, utilisation of coal-tar products and introduction of pulverised coal in boilers (locomotive as well as stationary) will be manned by a scientific and technical staff of more than 150.

Central Glass and Ceramic Research Institute

The Central Glass and Ceramic Research Institute's building is nearing completion in Calcutta.

It is proposed to set up a pilot-plant for optical glass manufacture. A sand-washing plant has already been installed, and following a survey of glass sands in the United Provinces, Central Provinces, Bihar, Punjab, Bombay, Madras and Travancore, more than 120 samples have been analysed and graded. Research work on multi-cellular glass and coloured glass is under way.

Central Leather Research Institute

Plans have now been drawn up for a full-fledged Central Leather Research Institute in Madras.

Sections will be devoted to leather testing, chemistry, bacteriology, microscopy and physics. There will also be a model research

tannery, a pilot-plant for tannin extraction and glue manufacture, and a workshop.

Central Food Technological Research Institute

Set up under the auspices of the C.S.I.R., the Central Food Technological Research Institute is housed in the Cheluvamba Mansion in Mysore—a gift from the Mysore Government.

Work will be conducted in 10 sections: storage and preservation; food surveys and raw materials; dietetics and field studies; food information and statistics; food containers; food adulteration; food sanitation; food processing; food engineering, and biochemistry and nutrition.

Central Drug Research Institute

Drug research is an integral part of India's health programme. The Central Drug Research Institute is being set up at Lucknow, with five main divisions dealing with chemistry, botany, pharmacology, biochemistry and microbiology and clinical science.

The 'Chattar Manzil' Palace, a gift from the U.P. Government, will house this institute. Remodelling of the building to suit the needs of the Institute is already under way.

Central Road Research Institute

Facilities for road research as undertaken in Western countries do not exist in India. Knowledge regarding materials and technique of road construction and its application to improvement of roads in this country is essential.

The proposed Central Road Research Institute will include in its programme of work: study of the technique of construction and maintenance of roads with due regard to the use of indigenous materials; survey of Indian soils with the object of evolving cheap rural roads; investigation of problems of road safety; development of an improved type of rural vehicle which, while efficient in operation, would be less destructive to rural roads than the existing types.

The Institute is to be located in Delhi, and a site of about 70 acres near the Delhi-Mathura Road, about a mile beyond Okhla railway station, is being acquired for this purpose.

Electro-Chemical Research Institute

Research of an applied character with a view to enlarging the production capacity and efficiency of existing industries and fostering new industries based on Indian raw materials will be the main function of the Institute. Provision is also being made for basic and fundamental research.

To start with, there will be two main divisions—Electrolytic and the Electrothermic. In addition, it is proposed to set up ancillary laboratories consisting of analytical, chemical engineering, testing and standardisation and electronic sections.

Central Building Research Institute

A Building Research Unit was set up at Roorkee in 1947 to deal with problems such as construction of low-cost houses and utilisation of cheap construction materials. It is proposed to extend the activities of this unit and establish a Central Building Research Station at Roorkee. Its functions will include: examination of building materials in common use and methods of applying them with a view to effecting economy and improvements; examination of new materials and processes; scientific diagnosis of difficulties and failure of materials in their application; and dissemination of information for the benefit of the building industry.

A STUDY OF THE MICROTONAL VARIATIONS IN FREQUENCIES IN KARNATIC MUSIC

C. S. AYYAR

IN a Conference held in April 1929, South Indian musicologists dicided that the 22 srutis of Bharata in Hindu melodic music have the following relative frequencies : —

European notes	Name of note or the swara	Relative frequency	Cyclic cents
C	Sa	1	0
D flat	ri	256/243	90
		16/15	112
D	Ri	10/9	182
		9/8	204
E flat	ga	32/27	294
		6/5	316
E	Ga	5/4	386
		81/64	408
F	Ma	4/3	498
		27/20	520
F sharp	ma	45/32	590
		64/45	610
G	Pa	3/2	702
A flat	da	128/81	792
		8/5	814
A	Da	5/3	884
		27/16	906
B flat	ni	16/9	996
		9/5	1018
B	Ni	15/8	1088
		243/128	1110

the figures in brackets, differing by a frequency ratio of 81/80, a comma, or 22 cyclic cents.

N.B.—For purposes of clarity, the twelve frets of the vina in the octave may be denominated ri, Ri, ga, Ga, Ma, ma, Pa, da, Da, ni, Ni and Sa higher—the capital letters standing for the *swaras* of the Diatonic Scale—Sa being the open *shadja* string, relative frequency being 1, the higher Sa being of rel. freq. 2 or 1200 cyclic cents.

In fixing the above values for the 22 srutis, South Indian musicologists apparently followed the method originally suggested by Helmholtz[1] and recently also advocated by Fox Strangways[2] and other Western interpreters of Hindu music, of tuning strings by true fourths and true fifths. They also decided in the 1929 Conference that as the shadja has been universally adopted as the fundamental for Karnatic melodic music, the 22 srutis may be defined as given below :—

Sa, (R_1 R_2) (R_3 R_4) (G_1 G_2) (G_3 G_4) (M_1 M_2) (M_3 M_4)

Pa, (D_1 D_2) (D_3 D_4) (N_1 N_2) (N_3 N_4)

R standing for Rishabha, G for Gandhara, M for Madhyama, D for Daivata, N for Nishada since Shadja and Panchama once decided on, cannot change in melodic music. Thus the 10 frets in the vina, besides Sa and Pa, have been given twin names. They went so far as to give examples *purely subjectively* of the ragas in which the several R's, G's, M's, D's and N's appeared in present-day melodic music, although the ascent and descent of swaras in ragas may continue to be defined by the 12 frets of the vina. To cite one instance, they laid down that da of Saveri raga is D_1 and has a relative frequency of 128/81.

Prior to the Conference mentioned above, the writer of the present note had studied the variations of the frequencies with the help of a Sonometer and in a paper, he had shown that there are, in Karnatic music, several prolongable notes in an octave, at which the human voice can stand for a definite length of time and which can be easily produced on the violin without a *gamaka* by means of the bow; and in the same paper he had avered that the *small semitone* as defined by Ellis[3] (relative frequency 25/24 above Sa) and the corresponding note above Pa of relative frequency 25/16 are prolongable notes and that, as the voice cannot stand steadily at frequencies 256/243 and 128/81, gamakas are produced from the above prolongable notes, as in ri and da of Saveri raga.

From his personal experience in violin play, the author had also reasons to doubt whether the difference in frequency in the 'andolika gamaka' *within the same swara*, viz., i. in Ri of Madhyamavati raga and ii. in Da of Begada raga could only be a comma (rel. freq. 81/80) as would appear from the theory of 22 srutis mentioned above or whether the variation was not much more.

With a view to finding a solution to these questions, the present author had arranged with the National Physical Laboratory, London, in 1933-34, to take photographs of vibration curves of the gamakas by means of a Duddell Oscillograph, and for purposes of their measurements, the gamakas were played by the writer on his violin according to the standard classical style. Relevant extracts from the Report of the Director of the National Physical Laboratory dated the

12th February 1934, given to the author, in this connection, are reproduced below :—

"The sound from the violin was received by a condenser microphone distant about 2ft. from the violin, and connected through a valve amplifier to one of the vibrators of a Duddell Oscillograph. The wave form of the sound was recorded on photographic paper by means of a revolving drum camera attached to the oscillograph. A time scale was provided on each record by a second vibrator which registered the wave form of the electrical output from a standard valve maintained tuning fork, operating at a frequency of 1000 cycles per second. The player and the receiving microphone were situated in a lagged cabinet so as to avoid as far as possible, any interference from extraneous noise. Communication between the player and the operator of the recording apparatus was maintained by a system of visual signals, controlled by the mechanism of the shutter on the recording camera, the player being warned one second in advance of the opening of the shutter and also at the commencement and conclusion of the exposure. The duration of the exposure was approximately one second in each case.

** ** **

"In all, seventeen records were made," (each record measuring 47 cm. C. S.)

etc.,as registered by the oscillograph records have been worked out and analysed by a Physicist and a full report about the same is being published elsewhere.

The important results are however, briefly summarised below :—

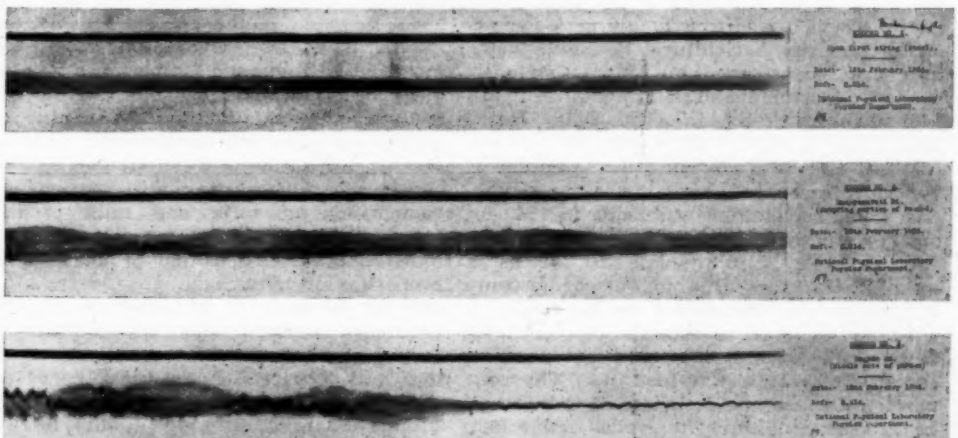
i. In da of Saveri raga, the variation (or gamaka) is from rel. freq. 25/16—a small semi tone above Pa—to rel. freq. 8/5—a semitone above Pa i.e.—a measure of 42 cyclic cents. On analogy, the gamaka in ri of Saveri raga will be from rel. freq. 25/24 to 16/15.

ii. The gamaka or variation in Ri of Madhyamavati raga is from rel. freq.10/9—(a minor tone above Sa) to rel. freq. 8/7 i.e., a measure of 49 cyclic cents.

iii. The gamaka in Da of Begada is from rel. freq. 5/3 (a minor tone above Pa)—to rel. freq. 12/7 i.e., a measure of 49 cyclic cents, a ratio of 36/35 subsisting between 9/5 and 7/4.

It is interesting to note that the variations in frequencies within the same swara are *quarter-tones* of definable frequency, which exist between notes arising at certain aliquot parts of the Sa and Pa strings. In (i) above the variation is 42 cyclic cents, while in cases (ii) and (iii) it is 49 cyclic cents.

The above is merely a preliminary study and does not claim to settle finally the important questions relating to the microtonal



The oscillograph records in respect of a few of the interesting gamakas are reproduced below :—

The frequencies of the various gamakas, variations in frequencies in Karnatic music. It is, however, the considered opinion of the author that these questions can be decided satisfactorily only by *objective*, and not by

subjective, methods. For instance, the author would suggest the frequencies should be actually measured by modern scientific methods similar to those outlined on this note. With a view to avoiding unnecessary controversy, the author would also suggest that the gamakas should be produced for purposes of these experiments by recognised masters of the art of violin play.

1. Helmholtz, "Sensations of Tone-p. 230. Translation" by Ellis. 2. Fox Strangways, "The Music of Hindostan (1914), p. 117 & his article on 'Music' in the *Legacy of India*, p. 311. 3. Ellis, "Helmholtz's Sensations of Tone," pp. 453 and 456.

INDIAN DAIRY RESEARCH INSTITUTE

THE Indian Dairy Research Institute, Bangalore, celebrated its Silver Jubilee last month. The Institute had a very chequerd career during its period of existence, and cannot as yet be said to have crossed the final hurdle. It is the youngest of the central institutes devoted to one of the most important branches of applied agriculture, and started its career at Bangalore as Imperial Institute of Animal Husbandry and Dairying in 1923 under the able guidance of the late Mr. William Smith. The main functions of the Institute were to develop foundation herds of important Indian milch breeds, and train personnel in the modern methods of dairy husbandry. Though a Scotsman by birth, Mr. Smith was a lover of Indian cattle, and inspite of many difficulties and obstacles the young Institute had to face, he succeeded in laying a strong foundation, and inspired his staff and students to the noble ideal of service to the cow. The Institute which was functioning as a section of the Imperial Agricultural Research Institute was reconstituted in 1936 into an independent department and the name of the Institute changed to the Imperial Dairy Institute. The question of expansion of the Institute has been engaging the attention of the Government of India for a long time, and a small beginning was made in 1940 by opening a new Imperial Dairy Research Institute at Delhi with the late Dr. Davies as its first Director. Due to various circumstances it was transferred to Bangalore in 1941, and in course of time the two institutes were combined into one under the name of Indian Dairy Research Institute. The proposal to expand the Institute, so that it will be in a better position to render active help to the country's biggest industry, is still under the consideration of the Government of India, and it is hoped that many suggestions that have been made will bear early fruits.

In course of its work the Institute has been able to develop fine pedigree herds of Gir and Sindhi cows and Murrah buffaloes, and distribute its surplus stock all over the country. The Institute has also an artificial insemination centre which will no doubt contribute a great deal towards the improvement of local stock. The service is gratis, and so far over 3,000 inseminations have been done with striking success.

Another important activity of the Institute is training of personnel in modern scientific methods of dairying. The Institute gives a two years diploma course, called Indian Dairy Diploma, recruiting nearly 35 students every year. In addition there is a short-course especially useful to man in the trade. Honorary workers are also taken for post-graduate work in dairy husbandry, dairy bacteriology, dairy chemistry and dairy technology. There is now a proposal to open a degree course in dairying.

The Institute has been able to develop its scientific sections considerably since 1941 under its able directors Dr. Zal R. Kothavalla and Dr. K. C. Sen. During this short period some interesting and important problems have been tackled. To cite only a few: study of the variation in the quantity and quality of milk due to different feeds and seasons, utilization of different feeding stuffs and bye-products of industries, chemical composition of milk and milk products, freezing point of milk, enzymes and vitamins of milk, composition of ghee, storage properties of butter and ghee, standardisation of methods of manufacture of dairy products, standardisation of chemical and microbiological methods of analysis of milk and milk products, nutritive value of milk and milk products, bacteriological quality of market milk, keeping quality of milk, microflora of dahi and butter, etc., etc.

With this brief description of the manifold activities of the Institute we wish it many useful years of active service for the benefit of our country, and its premier industry—dairying.

CAUSTIC EMBRITTLEMENT OF BOILER PLATE AND RIVET STEEL

B. R. NIJHAWAN

Assistant Director, National Metallurgical Laboratory, Council of Scientific and Industrial Research, Jamshedpur (India)

COMPREHENSIVE data exists on the present state of knowledge regarding caustic embrittlement of boiler plate steel. Extensive research work has been done on the subject in America, England and Germany. A review on the work done on the subject is given by Colebeck, Smith & Powell.[1] Parr and Straub[2] established the main features of this type of embrittlement from which later investigators took their clues. Co-related abstracts of Partridge and Schroeder[3] remain the standard of reference down to 1935. These researches have narrowed down the conclusions to two somewhat divergent schools of thought. Both views are, however, in agreement that the caustic embrittlement cracks differ widely from those ordinarily met with in common failures of metals such as fatigue or progressive cracks, fractures produced by direct tension and bending under dynamic and static stresses, etc. The latter cracks are usually transcrystalline, *i.e.*, the path of fracture runs across or through the crystals. Caustic embrittlement cracks in boiler steel are, however, typically intercrystalline following closely the grain boundaries.

The American and British researches have shown that the presence of alkali in the boiler-feed water and stress in the metal are essential for caustic embrittlement failures. Hydrogen absorption in the metal may also play an important part. Obviously no boiler-feed water can, in its normal state, contain enough alkali to cause cracking. The trouble, however, originates at leaky riveted seams and joints when alkaline feed water penetrates and fails to circulate freely thereby causing concentration of alkali due to evaporation of the water in the capillary spaces. As a result concentrated solution and even solid incrustations are formed in the capillaries of the respective joints and seams of boiler plates. A cracked boiler on dismantling reveals strongly alkaline whitish-brown incrustations at the joints between the plates and around the rivets. With the above condition another factor must also be present to cause cracking and that is high stress in the metal. Internal stress resulting from cold work through bad-riveting, excessive hammering bending for forming the drums, caulking, etc., is most important.

The stress must also exceed the yield point of the metal. Correcting by force, bad alignment of rivet holes, heavy caulking to ensure parallelism between the edges of the plates, excessive rivetting, pressure and use of improper snap-heads for riveting, etc., all contribute to introduce stress in the metal. Without, however, optimum chemical condition of water, the stress in the metal by itself is unlikely to contribute towards caustic embrittlement. Thus there should be first (1) Leakage in the joints that allows concentration in the capillaries of the boiler seams, (2) An embrittling boiler water and (3) High stress in the metal. Embrittling boiler feed water has been found to contain high alkalinity with low sulphate contents. Boiler Code Committee of A.S.M.E. have recommended ratios of sulphate to alkalinity as a precautionary measure against embrittlement as follows :—

Boiler pressure lbs. per sq. inch	0-150	150-250	over 250
Ratio of sulphate and alkalinity	1	2	3

However, cases of intercrystalline cracking have been recorded in boilers where the above ratios were consistently maintained. Straub and Bradbury[4] have recommended a sodium sulphate/total alkalinity ratio greater than 1·0 together with sodium chloride/total alkalinity ratio above 0·6 for steam pressure upto 250 lbs. per sq. inch.

The addition of phosphate to the water has not been reported to be effective where the chloride/alkalinity ratio fell below 0·2. Alumina additions have been reported to prevent embrittlement at higher boiler pressures above 500 lbs. per sq. inch. For intermediate boiler pressures of 350 lbs. per sq. inch both the chloride/alkalinity and sulphate/alkalinity ratio and also the ratios expressed by R_2O_3/SiO_2 appear to play an important part in controlling embrittlement.

The second school of thought sponsored by German workers in the field tends to hold the steel responsible for boiler plate failures and claims that to be satisfactory, the steel must be specially resistant to corrosion attack under extreme conditions of temperature and pressure. The paper by Athavale[5] represents the German Data on the subject claiming that alkali is not the chief cause of the embrittlement but rather the type and quality of steel and the local stresses that are present in the boiler; that caustic embrittlement depends upon hydrogen absorption ; and upon precipitation hardening phenomena due to the presence of nitrogen in steel. Germans have recommended the use of Izett non-ageing aluminium steels to prevent cracking.

The above claims have not been substantiated by Americans and British researches. Original Germans work which was undertaken following a disastrous boilers explosion in 1920, formed the Vereinigung der Grosskesselbesitzer. Their work ignored Parr and Straub's well-established features but emphasized the process of ageing in steel at boilers operating temperatures. Germans Izett non-ageing steel was expected to possess immunity to caustic embrittlement but it was later shown to fail in much the same way as boiler mild steel. Later German results have fallen in line with the results of others.

The term caustic embrittlement is a misnomer just as fatigue cracking is. As pointed out by Desch[6] the steel between the cracks does not become "brittle" but is merely fissured along the grain boundaries through external influences.

Caustic embrittlement has not been reported from welded or seamless drum boilers owing to complete absence of leaky rivetted joints providing narrow capillary spaces for concentration of alkalies, etc., unless at joints or fittings.

The author has examined a number of cases of caustic embrittlement failures of boiler plates and rivets. The results of some of the typical investigations are discussed below :—

In one case cracks were observed to have started from the rivet hole, extending into the interior of the plate as shown in Fig. 1. Fig. 2 shows the crack starting from the edges of a rivet hole at the joint between the boiler plates. Evidence of excessive rivetting pressure was left on the boiler plate in the form of deep circular indentations around the rivet holes made by the snap during rivetting as shown in Fig. 2. Deposits of reddish brown scale consisting of magnetic oxide of iron were observed in the crevices and at the contact surfaces of the lap joints from where pittings and several incipient cracks were observed to radiate. The reaction that takes place at the joints is :—$3Fe + NaOH + 4H_2O \rightarrow Fe_3O_4 + NaOH + 4H_2$.

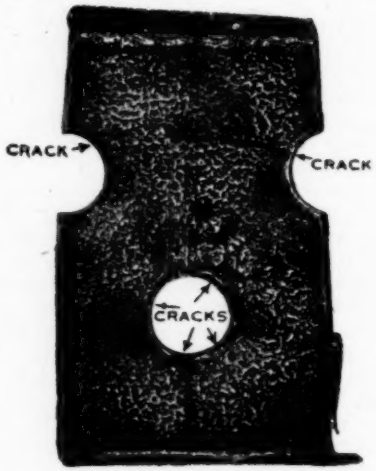


FIG. 1
Cracked Boiler Plate showing caustic-embrittlement cracks starting from rivet-hole edge

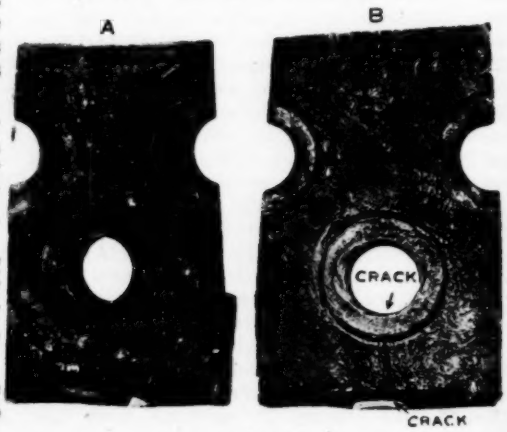


FIG. 2
Cracked Boiler Plate showing fine cracks and deep circular indentations around rivet holes

Samples of boiler feed water gave the following results on chemical analysis :—

		$\frac{Na_2CO_3}{NaOH}$ ratio	$\frac{Na_2SO_4}{NaOH}$ ratio	$\frac{Na_2SO_4}{\text{Total alkalinity expressed as } Na_2CO_3}$
1	Boiler parts taken through glass gauge cock	2·19	0·15	0·78
2	,, ,, ,,	1·26	1·89	0·28
3	Boiler blow down	0·72	0·61	0·22

Analyses of boiler steel gave the following results :—

Carbon	..	0·18%
Manganese	..	0·56%
Silicon	..	0·105%
Sulphur	...	0·027%
Phosphorus	..	0·035%

Hardness Test.—Hardness values were determined by means of the Vickers pyramid hardness testing machine using 30 kg. load on the surface of the cracked plate starting from the rivet hole edge, at intervals of 1/16″ apart, with the following results : 138, 136, 135, 139 V.P.H. Nos.

Brinell Hardness test with 3000 kg. load on the surface of the plate ¾″ away from the rivet hole gave a value of 137 B.H.N. The approximate tensile strength of the boiler shell plate calculated from the hardness value was about 30 tons per sq. inch.

Bend Test.—Test piece taken from the defective plates away from the cracked area, could be successfully bent through 180° without showing any signs of cracking at the outer surface of the bend.

Macro Examination. — Sulphur Print taken on a longitudinal section of the plates failed to reveal any abnormality. Macro-etching of the same sample showed satisfactory structure. Sulphur Print taken on the longitudinal section of one of the rivets showed freedom from sulphur segregation. On macro-etching some of the rivets, fine circumferential cracks were revealed on the undersurface of the rivet heads near the junction of the shank and head as shown in Fig. 5. Macro-structure of the rivets appeared to be satisfactory.

Microscopic Examination.— Section taken from near the cracked areas of the plate showed the normal fine-grained Sorbo-Pearlite and ferrite structures. Radial cracks starting from the edges of the rivet holes were observed. The main cracks had considerably opened out through corrosion. Several branching cracks were also observed. The branching cracks were observed in every case to be inter-crystalline as depicted in photo-micrographs Nos. 3 and 4. The main cracks had in most cases extended out to either side of the plate.

3 50 4 50

FIGS. 3 & 4

Showing micro-structure of the Boiler Plate and inter-crystalline caustic embrittlement cracks

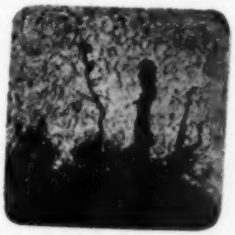


FIG. 5

Circumferential cracks in the boiler rivet at the junction of the shank head—considerably opened out through corrosion

Conclusions.—The results of chemical analysis and physical tests showed that the material of the boiler plate was of satisfactory quality. Macroscopic and micro-examination showed that the material was normal for Boiler quality plates and was free from abnormalities.

The inter-crystalline nature of the cracks starting from the edges of the rivet holes was definitely established by microscopic examination — a phenomenon associated with caustic embrittlement of boiler plates. That there was apparently leakage of water contents of the water in the capillaries of the imperfect and leaky rivet joints where the boiler feed water could not circulate freely, was evident from the deposition of solids at the plate joints and in the crevices. The boiler plate around the rivet-holes had been damaged through bad riveting as depicted in Fig. 2 showing deep circular indentations around the rivet holes made by the snap during riveting. This had

not only damaged the boiler plate, distorted the rivets and the rivet-holes, thereby causing an imperfect and leaky joint to develop but also had left the joints and seams in a state of severe stress—one of the essential causes of caustic embrittlement and cracking of boiler plates at the rivet joints. Such cracking of the boiler plates has always been known to be inter-crystalline in nature and micro-examination of the cracked regions of the boiler plate in the present case corroborated the inter-crystalline failure of the metal. The boiler water, judged from its chemical analysis, was probably not of an embrittling character although the controversy around the chemical analysis of embrittling and non-embrittling types of boiler waters, is still far from settled in the technical literature.

In the present case the caustic embrittlement of the boiler plate appeared probably, to be due to the rivet joints and seams having been in a state of stress by riveting which through damaging the plate, distorting the rivets and rivet-holes, had formed a leaky and imperfect joint. This caused leakage of water and consequent concentration and deposition of the mineral contents of the water and oxides of iron therein at normal boiler temperatures. Due to the same causes, the rivets had also developed cracking as shown in Fig. 5.

Another case of caustic embrittlement of the boiler rivets showed whitish-brown alkaline deposits at the area of contact between the rivet head and the boiler plate as shown in Fig. 6. In this case the rivet-heads were severed off from the shank through caustic embrittlement of the rivets. The chemical composition as well as the quality of the steel of the rivet was quite normal.

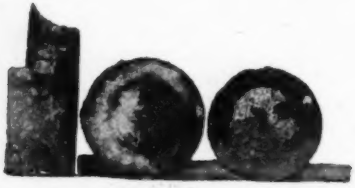


FIG. 6

Whitish-brown alkaline deposits at the underside of the rivet heads

Another case of caustic embrittlement cracking of the boiler plate showed the formation of cracks from rivet-holes and whitish incrustation on the plate as depicted in Fig. 7. The cracks on microscopic examination showed their inter-crystalline nature as shown in Micro-photograph 8. The boiler-plate steel was of sound quality and composition, showed freedom from abnormalities on micro and macroscopic examinations and gave very satisfactory physical properties on testing.

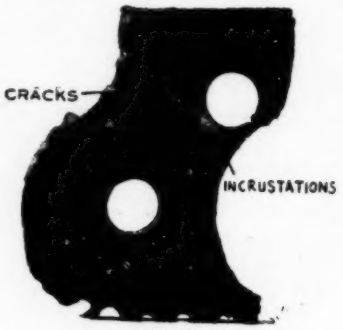
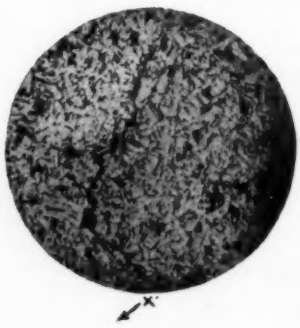


FIG. 7

Showing caustic embrittlement cracks at the rivet holes and whitish incrustations on the plate's surface

FIG. 8

Showing intercrystalline cracking in Boiler Plate owing to caustic embrittlement



50

FIG. 9

Inter-crystalline cracking in boiler rivets due to caustic embrittlement

XX' shows the path of the crack.

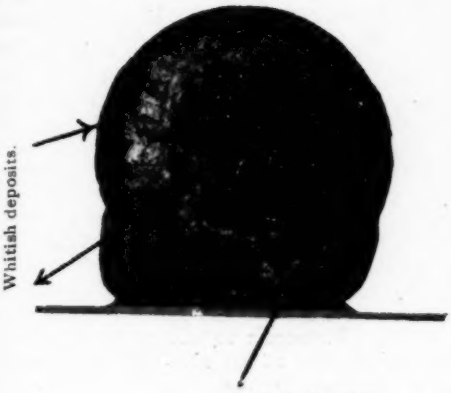


FIG 10

Whitish alkaline deposits at the rivet head

In another similar case of boiler-rivet failure inter-crystalline cracking and whitish alkaline deposits at the rivet heads are depicted in Figs 9 and 10. The rivet steel itself gave excellent properties on physical and metallurgical tests. Its chemical composition conformed to I.R.S. specification No. M7-39 for boiler quality rivets.

1. Colbeck, Smith and Powell, "Metal Treatment, Winter, 1942-43," **9**, (32), 171. 2. Parr and Straub, *Proc. Amer. Soc. Test. Mat.*, 1926, (26), 52. 3. Partridge and Schroeder, *Metals and Alloys*, 1935, **6**, 145; *Ibid.*, 1935, **6**, 355; *Trans. Amer. Soc. Mech. Engrs.*, 1936 **58**, 223. 4. Straub and Bradbury, *Mech. Eng.*, 1938, **60**, 371. 5. Athavale, *Korrosion and Metallschutz*, 1939, **15**, 73. 6. Desch. J., *Iron and Steel Inst.*, 1941, **143**, 94.

Note.—The cost of printing this contribution has been defrayed by a generous grant from the National Institute of Sciences, India,—*Ed.*

NATURE CONSERVATION AND NATIONAL PARKS*

THE concept of nature conservation embraces several distinct purposes such as conservation of plant and animal life, the scientific aspect which includes biological research; field research and experiment; the amenity aspect which deals with æsthetic and recreational side and the educational aspect. The æsthetic and recreational approach placed the main emphasis upon preserving the characteristic beauty of the landscape and upon providing ample access and facilities for open-air recreation and for the enjoyment of beauty in those areas. The major features of the Park are made easily accessible by providing roads, trails and bridges, and living accommodation in the form of hostels, etc. The scientific approach which in no way underestimates the æsthetic values, was primarily directed to the advancement of knowledge and its application to human welfare. "The educational aspect" as the Special Committee on Wild Life Conservation observes "is in many ways complementary to each and all of the others. True appreciation of scenery rests in part upon, and is certainly enhanced by, some understanding of the rocks and the variety of landscape which these induce, the shapes of the rocks and the variety of landscape which these include, the shapes of the valleys and summits, the flow of the streams, the cliffs and dunes and flats of the coast, and all the rich verdure with which they are clothed, are things which can invigorate and refresh the mind and upon which a deep culture can be based. The more widely this appreciation can be diffused, the sounder will be the mental and physical health of the nation."

The type of areas which are in need of conservation can be classified under the following categories:—

I.—*National Parks and Nature Reserves*: National Parks may be defined as extensive areas of beautiful and relatively wild country with characteristic landscape beauty which are also wild life sanctuaries for the preservation of big game, or other mammals and birds, in which access and facilities for public open air enjoyment are also provided, so that the people may be able to observe wild life of all kinds in its natural surroundings at close quarters. There is also need of nature reserves in the national parks, which act as breeding reservoirs for shy animals, which it is desired to encourage and which are not accessible to visitors.

II.—*Geological Monuments and other areas of outstanding value*: These include rocks, exposures or sections which because of their great geological interest should be preserved as Geological Monuments, and which

* Abstract of Presidential Address delivered by Mr. M. S. Randhawa, before the Section of Botany, 36th Indian Science Congress, Allahabad, 1949.

should be given the same protection as to archæological buildings and monuments. These should be protected from mining, excavations, prospecting and drilling or similar operations.

III.—*Local Educational Reserves*: These include small areas of local country containing representatives of local flora, which are reserved for educational purposes for the benefit of schools and colleges.

National Parks

Uncontrolled destruction of wild life has been going on in many countries all over the world, and as a result of this natural fauna has dwindled and many species have become extinct. In countries of Western Europe like England the process of death and destruction has reached such limits that the sight of a wild bird or animal is regarded as an event of such importance, that it inspires many lovers of nature to write letters for publication in *Times*, saying that they heard a cuckoo at such and such a place. With the modern means of rapid transport such as motor car, jeep, and aeroplane, the whole world is becomng so speedily opened up to travellers, tourists and traders, and with the increasing population, so much uncultivated land is coming under the settler's plough, that the need for the preservation of fauna in national parks and reserves is being increasingly felt.

National parks and reserves were originally established in the United States of America. There are 26 National Parks in America covering a total area of 1,500 square miles. The first National Park to be established in the U.S.A. was the Yellowstone National Park in 1872.

The lead of U.S.A. has been followed by other countries such as Canada, Australia, New Zealand, and the Union of South Africa. In South Africa, the Sabi Game Reserve was founded in 1898, and in 1926 it was renamed as Kruger National Park. The Albert National Park in Belgian Congo was created mainly due to the efforts of an American naturalist Carl Akeley. Due to the creation of this sanctuary for wild animals the Gorilla has been saved from extinction. The Swiss National Park is about 62 square miles in area, and arrangements are provided in it for enabling the student and tourist to enjoy the more spectacular fauna and flora.

National Parks In India

In India the necessity of creating National Parks has found a tardy recognition. Dr. Baini Prasad has thus summarised information about National Parks in India:

"In 1934 a very great advance was made in the United Provinces through the great personal interest taken by the enlightened Governor of the Province, Sir Malcolm Hailey, as a result of which the National Parks Act of 1934 was passed. This Act provided for the establishment of National Parks and for the preservation of wild animal life or other objects of scientific interest and for incidental matters provided therein. As a result, the Hailey Park was demarcated as a National Park in the famous Patli Doon and the hill forests to the south of it consisting roughly of an area of 99·07 square miles. Reference may also be made here to the Chamrajanagar Sanctuary of the Mysore State Forests which had been established with a view to offering complete immunity for animals and thereby making it possible for them to thrive without interference. Introduction of other animals not found in the area was to be attempted, and the sanctuary was to provide facilities for the scientific study of the life-histories of different indigenous species of game."

National Nature Reserves

There is also a clear need of establishing nature reserves within national parks. The principal purpose of such nature reserves is to establish breeding reserves for scientifically encouraging particular species or communities of species the preservation or wider spread of which within the park it is desired to promote. In such reserves public access would have to be more or less restricted.

The authorities who are made responsible for the management of the reserves should keep close touch with University or educational centres, as well as main local natural history societies. A need would also arise of providing small handbooks on nature reserves, explaining with the aid of maps, photographs, and sketches the scientific significance of the reserve.

Local Educational Reserves

Lack of field training for teachers as well as students is one of the most serious deficiencies in current biological education in India. Without field training or facilities for nature study, teaching of Botany or Zoology tend to become lifeless and warped. Thus here is need of local educational reserves for all colleges where biological sciences are taught. The local Educational

Reserve is the counterpart of the college museum and the laboratory. These reserves would open a vast and a stimulating field of knowledge in a discipline which trains such mental attributes as acute power of observation, patience, concentration, detailed ordering of thought, and the appreciation of form and colour. Visits to these reserves under proper guidance would provide a liberal education to the students in one of the most stimulating and formative fields of thought. These are gains which cannot be quantified in terms of money. A beginning in this direction has been made in Delhi Province, where the local government has placed an area of 20 acres on the 'Ridge' at the disposal of the University of Delhi, Department of Botany. This piece of land will be enclosed with barbed wire, representative trees and shrubs would be labelled and efforts would be made to introduce other local plants also which can grow under these conditions.

Need of New Policy

With the liquidation of the feudal order and the merger of states into unions, the problem of wild life preservation has acquired a new significance. Whatever may be the faults of princes and rajahs, it must be said to their credit that they preserved the wild animals and forests of their states rather well. With the growing demands of cultivators who want to save their crops from harmful animals, there is need of clear formulation of policy. There is immediate need of initial survey of all proposed National Parks Areas. While there is necessity of preservation of rich flora and fauna in the National Park Areas, the general wild life policy must be such as will not prejudice the use of developed agricultural land. The interests of the cultivator and the lover of nature must be harmonised. The apprehensions of farmers that National Parks and Nature Reserves will develop into uncontrolled sanctuaries where pests and weeds will be allowed to flourish, and which will spread into surrounding agricultural lands must be allayed. The biologists must give lists of harmful and useful birds and animals. While the friends of the cultivator should be encouraged in the National Parks, the enemies must be exterminated. The biologists should also give a finding whether campaigns should be started for the destruction of wild boars, porcupines, monkeys, bats and parrots who cause enormous damage to crops and gardens. Before any such campaigns are started, it should be ascertained whether wholesale destruction of certain birds or animals may not have harmful repercussion, elsewhere, on account of the upsetting of balance of power between various organisms. An action which *prima facie* may appear sensible and desirable may have far-reaching and most unpleasant and unforseen consequences fifty years hence.

Need of a Central Biological Service for India

In India also there is need of a Central Biological Service under the Ministry of Agriculture of the Government of India to deal with problems relating to conservation of nature, national parks and fisheries.

The Committee further enumerates the functions of the proposed Biological Service as follows:—

The scientific and practical management and maintenance of the series of National Nature Reserves in such a way as to provide:—

(*i*) Reservoirs for the conservation of the main types of wild life (plant and animal species and communities) represented in the country;

(*ii*) Facilities for the conduct of fundamental and applied research and survey;

(*iii*) Certain educational facilities for students;

(*iv*) Facilities for the amateur naturalist and members of the public to observe and enjoy nature.

The Central Biological Service may be co-ordinated with the Indian Forest Service and may form a part of it. It should be staffed by scientists with appropriate qualifications, and should be equipped for survey and research in the field and in the laboratory, with the object of determining the distribution, ecology, genetics, general structure and behaviour of natural populations and physical conditions in which they live. The reserves will be used by the scientists of the Central Biological Service as field laboratories for the study of wild life and its control, and to elucidate the causes which promote or modify the maintenance of the living equilibrium in such areas. In conjunction with the Universities fundamental research on problems of nature conservation

can also be fostered. Best results will, however, be obtained if free flow of staff between the Universities and the Central Biological Service is allowed. This will be of mutual advantage. The scientific workers in Universities will benefit by field experience, while the field workers of the Central Biological Service will maintain contact with problems of fundamental research, and recent advances in research in biological sciences.

Protective Legislation

In January 1935, the Government of India convened an All-India Conference for the Preservation of Wild Life at Delhi, with a view to reviewing the position of fauna and flora as it existed at the time and considering generally problem of protection of the animals peculiar to India. The Conference prepared two lists of species, first of animals that were to be protected as completely as possible, and second of those which could only be hunted, killed or captured under a licence, in some cases subject to a bag limit. The Conference further laid stress on the establishment of wild life sanctuaries. It was further recommended that the duty of preserving of fauna should be assigned to forest departments in the areas under their charge, and the necessity of co-operation of police and magistracy was also urged.

A comprehensive protective legislation was enacted in 1933, in the Punjab Wild Birds, and Wild Animals Protection Act.

Protecting Plants

There is need of protective legislation on the lines of the Punjab Act of 1933 in other provinces also. Moreover the Act should be made more comprehensive and cognizance should be taken of the plant world too. Plants which are rare or striking, beautiful or odd should be scheduled for protection in areas where this is necessary. Rare plants like species of *Lycopodium*, *Ophioglossum*, and *Osmunda;* and other beautiful plants like *Orchids*, *Rhododendrons* and *Meconopsis*, etc., which are liable to excessive collection by botanists and which are widely plundered and uprooted by 'pleasure' pickers should also be given protection. Their collection should be permitted only under proper control.

Plant Sanctuaries in the Himalayas

Some of the Himalayan Valleys are in grave danger of losing their character on account of excessive grazing and growth of *Rumex*. Apart from other vegetation, the sheep and ponies which are taken to Alpine meadows above the tree line by graziers in the months of April and May, graze mainly on *Rumex*. A symbiotic relationship has developed between the sheep and *Rumex*. While the sheep feed on *Rumex* in their turn they manure the pasture land with their droppings, which in turn further encourages extensive growth of *Rumex*. The result has been that more attractive, but less edible alpine plants are driven out by *Rumex*, which now covers big areas in Himalayan alpine valleys like that of Pindari Glacier. In the interest of tourist industry, it is very necessary that some of the beautiful alpine Himalayan valleys should be declared as plant sanctuaries; and not only collection of beautiful and rare plants should be controlled, but at the same time, the grazing of sheep and cattle should also be prohibited. This is necessary in the interest of not only tourist industry, but also for checking of soil erosion as well as botanical studies.

Note.—The cost of printing this article has been met from a generous grant-in-aid from the Indian Council of Agricultural Research, New Delhi.

THE INDIAN CHEMICAL SOCIETY

ON the occasion of the celebration of the Silver Jubilee of the Indian Chemical Society in January 1949, Prof. P. Ray, M.A., F.N.I., the President of the Society, delivered a thought-provoking address in which he has raised a number of important issues like, the standard of under and post graduate training in science, pure *versus* applied science, the medium of instruction, and multiplication of scientific associations in our country. A Silver Jubilee brochure also was published on the occasion.

The Silver Jubilee Address

In taking stock of the progress made, Prof. Ray has observed as follows:—

> "Looking back upon the past twenty-five years of our existence and making a dispassionate analysis of our achievements and activities, we can discover little justification for complacence or gratification. The standard of our publications has failed to reach the level which we might have not unreasonably expected from the number of

workers in various universities and research institutions of our land."

Though it would prick one's self-pride to the quick, it would be self-deception if one would not agree at least partially with his observation that our activities "have not been of the order that might inspire confidence in a better or brighter future." Such a reckoning at this stage of India's development should urge us open our eyes and work on indefatigably till India would become the torch bearer of world's scientific knowledge. With the present professed sympathy of our Government to matters scientific, it should not be difficult for our leaders of science to instil courage and enthusiasm among the young workers on whose efficient and faithful performance alone will depend the growth and application of future science in India. Opportunities must be created and no pains should be spared to raise the standard of our research work if we consider our present achievements to be below par, so that the country does not lag very much behind advancing fronts of world chemistry.

Prof. Ray has truly said that the basic scientific training in our schools and colleges is far below the standard aimed at. One uniform high standard of teaching and study should be enforced in our universities so that a supply of uniformly qualified band of scientific workers may be assured for the service of the country.

Advocating the need for a harmonious and orderly development of pure and applied sciences, Prof. Ray has said that if India is to take her rightful position in the world of science and render useful service to humanity, she cannot afford to ignore the cultivation of pure science.

Adverting to the question of medium of instruction and expression for science in free India to-day, Prof. Ray has reminded us of the international character of science and its development through the co-operative efforts of all the workers of all the lands through all the ages, and has justly stressed the advantages in retaining the international scientific terminologies nomenclature unchanged and in continuing to use English as the medium for the publication of scientific researches, as well as for discussion in all-India scientific bodies.

One cannot agree totally with Prof. Ray when he styles the starting of scientific orgnisations other than the Indian Chemical Society as an unwholesome tendency caused by fissiparious mentality. India is a vast country and can accommodate any number of societies. Perhaps a healthy scientific rivalry among the various organisations persued on strictly scientific level may further the scintific activity in the country.

THE SILVER JUBILEE BROCHURE (1924-1948)

A perusal of the 35-page Silver Jubilee Brochure gives a bird's eye view of the pursuit of Chemistry in the 19th century as also of the origin and development of Chemical research in India. Although the beginning of the modern school of chemistry in the country is said to date back to 1873 when late Sir Alexander Pedler came to Presidency College, Calcutta, as Professor of Chemistry, the credit of developing the teaching and modern researches in all branches of chemistry would certainly go to late Sir Prafulla Chandra Ray who joined the same institution as a Lecturer in Chemistry in 1889. Sir Prafulla Chandra was undoubtedly the father of modern Chemistry in India. It was due to his efforts that the Indian Science Congress in 1914 and the Indian Chemical Society in 1924 were started. Sir P. C. Ray was the Founder President and Dr. J. N. Mukherjee, the first Secretary of the Indian Chemical Society. During the 25 years of its existence the Society has grown in strength and usefulness. In recognition of its activities, the Society is represented at a number of technical and educational committees. The Society is housed in the University College of Science and Technology, Calcutta. Sir P. C Ray had made a generous gift of Rs. 10,350 for building a house of its own. Apart from receiving a substantial help from the University of Calcutta, the Society has also been supported by other Indian and State Universities, as also by many research organisations through annual or occasional grants.

The brochure contains short notes about research work carried out in India in the several branches of chemistry. It also contains photographs and life sketches of its Presidents as also the photographs of its Honarary Members.

B. H. IYER.

LETTERS TO THE EDITOR

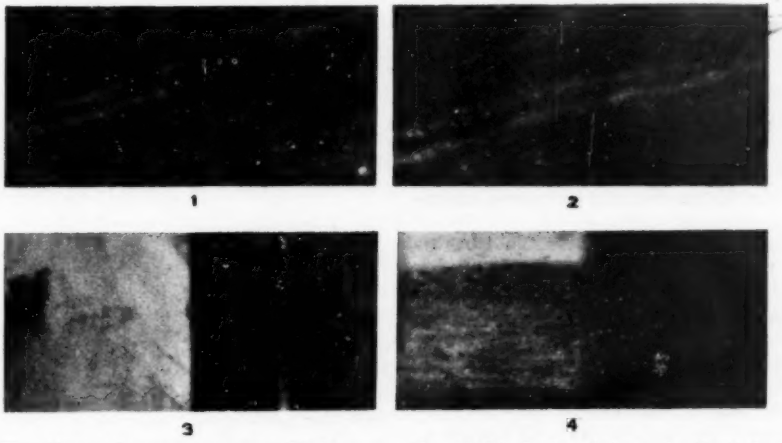
	Page
Action of Wood on a Photographic Plate—V. P. Narayanan Nambiyar	284
A Note on the Scattering of Light in Plastics—V. P. Narayanan Nambiyar	286
The Raman Spectrum of Cadinenic Sesquiterpene—V. M. Padmanabhan	287
An Equation for the Comparison of Surface Tensions by Unstable Pendant Drops—K. G. Parvatikar	288
The Millerian Direct Sine Formula and the Converse Cotangent Formula—P. R. J. Naidu	288
Berek's Compensater—P. R. J. Naidu	289
Magmatic Water in Chalcedony and Agate, Bhera Ghat, Jubbulpore District, Central Provinces—H. L. Chhibber	290
Electrolytic Preparation of Azo-Dyes. III. Dye Formation at an Iron Anode—M. V. Sitaraman and V. V. Raman	291
Surface Tension of Solutions of Cetyl Pyridinium Bromide—B. K. Banerji	292
Adverse Effect of Mixing Tapioca and Sweet Potatoes in Wheat Flour—P. N. Agarwal	294
Attempts towards the Synthesis of Substituted Polyguanides—P. R. Gupta and P. C. Guha	294
Estimation of Acetic Acid in Pyroligneous Liquors—P. S. Mene and U. R. Warhadpande	296
Crisscross Addition to Hydro-Aromatic Ketazines—D. B. Dutt and P. C. Guha	297
Embryo Culture to obtain F_1 Plants of Incompatible Crosses in Corn (Maize)—P. Uttaman	297
A Note on the Vegetative Propagation of Lilium Longi florum Wall.—P. Kachroo	299
A Note on the Micro-Organisms Present in Date-Palm Juice (Sendhi)—Mohan Babu Naidu and J. Lakshmikantham	299
Proliferation of Spikelets in Pennisetum Polystachyum, *Schult*—C. Rajasekhara Mudaliar and D. Daniel Sundararaj	301
Rain of Prawns in Siam—B. Sundara Raj	302
Anti-Histamine Activity of Substituted Benzhydryl Amines—(Mrs.) Ranita Aiman and M. B. Gharpure	303
Processes of Separation Involving Dialysis—S. L. Sastry	305
Gestation in the Oriental Vampires—P. A. Ramakrishna	307

ACTION OF WOOD ON A PHOTOGRAPHIC PLATE

Wood possesses the very interesting property of acting on a photographic plate in total darkness and registering clearly a picture of it thereon. This property of wood was studied in some detail by Russel,[1] who experimented with a number of European timbers and classified them from the standpoint of their relative activity on a photographic plate. A similar investigation in regard to Indian timbers seemed desirable. For this purpose a very wide variety of Indian timbers was selected. The specimens were mostly rectangular in shape and their broad faces were carefully planed and rendered perfectly smooth. Each specimen was then placed with one of its smooth faces in contact with the sensitive side of a photographic plate (Ilford Special Rapid) in a dark room and the wood and the plate were wrapped completely in a thick black paper, and placed in a cardboard box. The box itself was placed in a bigger light tight box, and the latter was carefully wrapped in black cloth.

To start with, exposures ranging from 30 minutes to about 18 hours—those tried by Russel and found to give satisfactory results in the case of European timbers, were tried. The plates were developed in the usual way, but surprisingly enough, the results were negative, there being practically no perceptible action during the period on the type of photographic plate used. Thereupon longer

exposures including extremely long ones, ranging from 48 hours to about 72 hours, were tried. It was not till prolonged exposures varying from 48 hours to 72 hours were given that the specimen was found to register a clear picture on the plate. This was found to be generally the case, with all the species of timbers subjected to investigation. Indian timbers therefore seem to be comparatively slower from the point of view of their photographic activity than their European counterparts, the most inactive of which did not, according to Russel, require more than 18 hours exposure for satisfactory results. It is however likely that the photographic material used by Russel was faster. Photograph 1 shows the picture obtained with a block of rose-wood (*Dalbergia latifolia*). The time of exposure was 72 hours.



1 2

3 4

The action of sunlight, the relative influence of the different parts of the spectrum and the effect of ultra-violet radiation on the photographic activity of the specimen, were next investigated. The piece of wood was half covered with thick black paper and exposed to the source of light for 10 minutes. It was then put in the usual way in contact with a photographic plate. The plate when developed was found to give a dark picture in the region where the light fell and only a faint picture of the part which was kept unexposed. Light therefore has the distinct effect of increasing the photographic activity of wood. It was further found that the part covered by the red filter was least active and that by the blue filter most—the activity in the latter case being almost the same as if that part was exposed directly to sunlight. Though the effect of ultra-violet radiations does not seem to have been investigated by Russel, the other results are similar to those obtained by him. Photograph 2 represents the picture obtained in the case where the left half of the specimen was exposed to the action of ultra-violet radiation and the right half was covered with thick black paper. The difference between the two portions and the demarcating line between them are distinctly noticeable.

The activity was much more pronounced in the case of white-cedar (*Dysoxylum malabaricum*) which gave a distinctly darker picture than teak (*Tectona grandis*). Photo- obtained. The left white portion represents the region acted upon by white cedar and the right dark picture is that due to teak-wood.

If, as was suggested by Russel, the action exerted on a photographic plate was really due to the presence of hydrogen peroxide produced by the resinous bodies present in the wood, the elimination of such bodies must arrest the activity. One of the specimens was therefore placed in a mixture of benzene and alcohol and allowed to stand in it for over three days. The resinous bodies, being soluble in the mixture, were extracted by the solvent from the wood. The specimen was then put in contact with a photographic plate in the ordinary way but it was found on development that the wood had practically ceased to be active. It therefore seems true that the resinous bodies present in the wood are responsible for its photographic activity. Whether the activity is

really due to the presence of hydrogen peroxide, as suggested by Russel, remains a moot point which requires to be further investigated. Experiments in this direction are now in progress. Photograph 4 shows the pictures obtained with two blocks of wood one inch square cut from the same specimen of teak. One of them (right half) was placed in a mixture of benzene and alcohol as described above and the resinous bodies extracted. The picture registered by it was extremely faint and almost imperceptible.

Further experiments with different species of Indian timbers are now in progress. Details will be published elsewhere.

Department of Physics,
Pachaiyappa's College,
Madras, V. P. NARAYANAN NAMBIYAR.
May 28, 1949.

1. Russel, W. J., *Proc. Roy. Soc.*, 1897, **61**, 424-33.

A NOTE ON THE SCATTERING OF LIGHT IN PLASTICS

THE study of the molecular structure, constitution and properties of plastics, has been the subject of extensive experimental investigation.

There are today innumerable varieties of plastics at present in everyday use in industry. Of the different types so far manufactured, some, at any rate, are remarkably clear and transparent and very definite in their optical properties. It occurred to the author that a study of the scattering of light in such specimens could with success be undertaken to unearth useful information regarding the molecular structure and constitution of the specimen. With this object in view the present work was undertaken.

The plastics selected for the present investigation is the popular variety commercially known as 'Perspex' (Unplasticised). 'Perspex' [methyl methacrylate $CH_2{=}(CH_3)\,COOCH_3$] is the registered trade name for the acrylic resin sheets and blocks manufactured and sold by the Imperial Chemical Industries, Limited, and possesses an outstandingly high degree of light transmission in all wave-lengths throughout the visible range. This substance is very steady at ordinary temperatures and possesses very definite physical properties. Some of its physical constants already determined,[1] are reproduced in Table I.

TABLE I

Specific gravity at 20° C.	..	1·19
Refractive index for the 'D' line at 20° C.	..	1·4900
Softening point	..	105° C.
Thermal conductivity	..	$3{\cdot}5\times10^{-4}$ c.g.s. unit
Coefficient of expansion	..	$80{\cdot}0\times10^{-6}$/° C.
Specific heat		0·35

The specimen selected was in the form of a cube of about 1 inch in size with perfectly plane and polished surfaces.

The specimen under experiment was kept immersed in dust-free distilled water contained in a rectangular cell. The cell was suitably blackened on the outside excepting for three windows. Sunlight was used as the source of illumination. The factors of depolarisation ρ_u, ρ_v and ρ_h with the incident light respectively unpolarised, and vertically and horizontally polarised, were determined by the usual Cornu method.[2] Suitable precautions were taken to eliminate or minimise all sources of incidental error.

The results of the investigation are given in Table II. The fourth column in the table gives the value of ρ_h calculated from the observed values of ρ_u and ρ_v applying the general Reciprocity relation $\rho_u = \dfrac{1+\frac{1}{\rho_h}}{1+\frac{1}{\rho_v}}$.

The agreement between the calculated and the observed values of ρ_h is quite satisfactory. $\Delta\rho_u$ in the last column is the difference between the observed value of ρ_u and the anisotropic part of ρ_u which may, to a first approximation, be considered as equal to $\dfrac{2\rho_v}{1+\rho_v}$. This is a function of the size of the scattering centre.[3]

TABLE II

ρ_u	ρ_v	ρ_h		$\Delta\rho_u$
		Observed	Calculated	
9·3%	4·5%	84·0%	86·5%	0·68%

From an analysis of the results, the following conclusions can be drawn:—

(1) The low value of ρ_u suggests that the light scattered by the specimen is strongly polarised.

(2) It is found that the value of ρ_h is less than 100%. This furnishes positive

evidence for the existence of molecular aggregates in 'Perspex', the size of which is not excessively small compared with the wave-length of light.

(3) The value of ρ_v (4·5%) is a measure of the optical anisotropy of the scattering molecules.

(4) $\Delta\rho_u$ represents the depolarisation due to the finite size of the scattering centres, and can consequently be regarded as a function of the size of the scattering centre. The low but definite value of $\Delta\rho_u$ suggests that the molecular aggregates are not of large size.

(5) The calculated value of $\Delta\rho_u$ is found to be 0·68%. This compares favourably with the order of the value of $\Delta\rho_u$ obtained by Krishnan for optical glasses.[4] The molecular aggregates in 'Perspex' therefore, seem to be approximately of the same size as those in optical glasses.

Further experiments with other varieties of plastics are in progress. Details will be published elsewhere.

The author is grateful to Messrs. Mehtallia Plastics, Madras, for the specimens of plastics they were good enough to supply him for the purpose of this investigation.

V. P. NARAYANAN NAMBIYAR.
Department of Physics,
Pachaiyappa's College, Madras,
June 7, 1949.

1. *Plastics Technical Bulletin*, February 1944, No. 10 (Imperial Chemical Industries, Limited), 2. Krishnan, R. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **1**, 915-17. 3. — and Venkat Rao, P., *Ibid.*, 1944, **20**, 109-16. 4. —, *Ibid.*, 1936, **3**, 212-20.

THE RAMAN SPECTRUM OF CADINENIC SESQUITERPENE

ALTHOUGH numerous investigations on the Raman spectra of terpenes have been made, the studies on sesquiterpenes are comparatively few. Mr. Sukh Dev Lala (1948) of this Institute has isolated a dextro-rotatory cadinenic sesquiterpene from the essential oil of *Hardwickia pinnata* and has very kindly placed the sample at the disposal of the author for the investigation. By means of ozonalysis and dehydrogenation he has come to the conclusion that this compound is a structural isomer of α-cadinene, and is a mixture of two isomeric hydrocarbons. It appeared desirable to study its Raman spectrum with a view to get some information concerning its constitution.

The Raman spectrum obtained by using λ 4358 of the mercury arc as exciting radiation is reproduced in Fig. 1. The spectrum exhibits a series of 53 distinct frequency shifts.

104, 142, 183, 282, 310, 330, 366, 390, 428, 468, 485, 515, 530, 565, 588, 625, 667, 691, 707, 743, 763, 781, 818, 848, 875, 899, 909, 935, 959, 988, 1028, 1055, 1115, 1160, 1191, 1220, 1254, 1294, 1313, 1328, 1377, 1440, 1462, 1615, 1648, 1678, 2823, 2865, 2893, 2925, 2966, and 3044 cm.$^{-1}$ The appearance of a fairly large number of frequency shifts in the Raman spectrum may be attributed to the complexity of the sesquiterpene under investigation. Some characteristic features of the spectrum may be mentioned. Of the five intense lines, (1648, 1678, 1440, 2855 and 2920 cm.$^{-1}$), 2855, 2920 and 1440 are characteristic of the decaline ring present in the sample. The two intense lines 1648 and 1678 cm.$^{-1}$ are evidently due to C=C linkage. Comparing the frequency shifts of these lines with those due to C=C linkage appearing in other terpene compounds such as Sabinene, Limonene, Carvomenthane, and Sylvestrene, it may be inferred that these lines are due to the presence of one internal and one external C=C linkage. Lines with frequency shifts less than 200 cm.$^{-1}$ may be

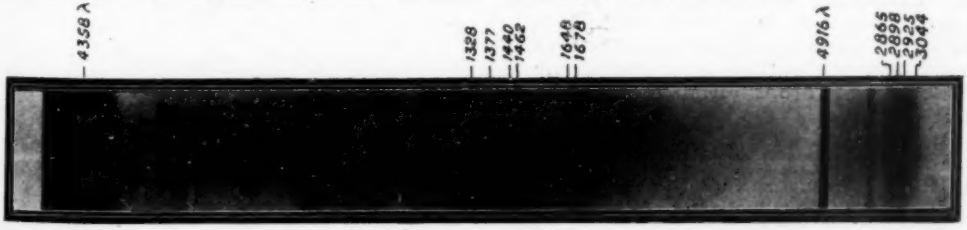


FIG. 1. Raman spectrum of a dextro-rotatory cadinenic sesquiterpene isolated from the essential oil of *Hardwickia pinnata*.

attributed to deformation oscillation of the benzene rings against each other. Further discussion of the results is not possible at present for want of data concerning the Raman spectrum of cadinene.

Physics Department, V. M. PADMANABHAN.
Indian Institute of Science,
Bangalore,
August 2, 1949.

1. Sukh Dev Lala, "Thesis for Ph.D.," East Punjab University, 1948.

AN EQUATION FOR THE COMPARISON OF SURFACE TENSIONS BY UNSTABLE PENDANT DROPS

WORTHINGTON[1] has shown that whatever the liquid, if the quantity $\beta = 2b^2/a^2$ (where b is the radius of curvature at the apex, and a^2 is the capillary constant) is the same for two drops coming from tips of different radii r_1 and r_2, then the conditions for similar shape of the two drops are that

$$\frac{2b_1^2}{a_1^2} = \frac{2b_2^2}{a_2^2}.$$

When drops have similar shape, all corresponding linear dimensions of the two drops will be proportional to one another so that

$$\frac{b_1}{b_2} = \frac{a_1}{a_2} = \frac{r_1}{r_2}$$

and for a given shape, the equatorial diameter de of a drop is proportional to b.

$$\text{i.e.,} \quad \frac{b_1}{b_2} = \frac{\frac{de_1}{r_1} \times r_1}{\frac{de_2}{r_2} \times r_2} = \frac{de_1}{de_2}, \qquad \text{(i)}$$

where the subscripts 1 and 2 refer to similar drops of two different liquids. Recently R. C. Brown and H. McCormick[2] in considering the detachment of drops from a conical tip, have shown that, provided the angle of contact between the liquid and the surface of a conical tip is the same, *all* drops forming on a cone of given angle are similar in shape at the unstable stage. The condition of constant contact angle is, of course, achieved in practice by ensuring that the angle is zero, *i.e.*, that the liquid wets the tip.

Therefore for a given shape (say S)

$$\beta = \frac{g\sigma_1 b_1^2}{\gamma_1} = \frac{g\sigma_2 b_2^2}{\gamma_2},$$

where σ_1 and σ_2 are the effective densities and γ_1 and γ_2 are the surface tensions of the two liquids respectively.

$$\text{i.e.,} \quad \frac{\gamma_1}{\gamma_2} = \frac{\sigma_1 b_1^2}{\sigma_2 b_2^2}$$

and using equation (i),

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1\, de_1^2}{\sigma_2\, de_2^2}. \qquad \text{(ii)}$$

Equation (ii) permits one to calculate the ratio of surface tensions of two liquids, if it is possible to photograph hanging drops at the unstable stage.

This work arose as a result of my similar experimental investigations on surface tension problems under the direction of Dr. N. R. Tawde of this Institute to whom I offer my grateful thanks.

Physics Department,
Royal Inst. of Science, K. G. PARVATIKAR.
Bombay,
June 22, 1949.

1. Worthington, *Proc. Roy. Soc.*, 1881, **32**, 332.
2. Brown, R. C., and McCormick, H., *Phil. Mag.*, 1948, **39**, 420.

THE MILLERIAN DIRECT SINE FORMULA AND THE CONVERSE COTANGENT FORMULA

THE Millerian Direct Sine Formula

$$\frac{\sin AB}{\sin AC} \times \frac{\sin DC}{\sin DB} = \frac{\begin{matrix} h\,k\,l \\ h'k'l' \\ p\,q\,r \end{matrix}}{\begin{matrix} h\,k\,l \\ p\,q\,r \\ h'k'l' \end{matrix}} \times \frac{\begin{matrix} p'q'r' \\ p\,q\,r \\ p'q'r' \end{matrix}}{\begin{matrix} p'q'r' \\ p\,q\,r \\ h'k'l' \end{matrix}}$$

and its converse cotangent equivalent, $p \cot AB - q \cot AC = (p - q) \cot AD$ (for anharmonic cases) and $\cot AB + \cot AD = 2 \cot AC$ (for harmonic cases) is without

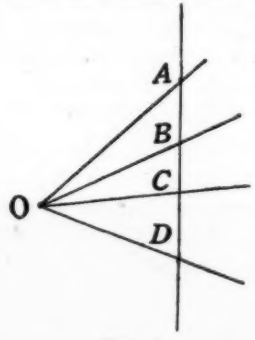


FIG. 1

proof in text-books of crystallography, possibly because it is simple. Tutton[1] remarks, "it is readily capable of proof"

Barker[2] remarks, "Miller showed that the four sines of the above formula can be rearranged into another from involving cotangents." Since 1933, I have been giving the following proofs to my classes in crystallography. Let OA, OB, OC and OD be a zone sheaf intersected by a fifth zone ABCD forming a cozonal quartette.

Then $$\frac{AB}{OB}=\frac{\sin AOB}{\sin OAB} \quad (1)$$

$$\frac{AC}{OC}=\frac{\sin AOC}{\sin OAC} \quad (2)$$

$$\frac{DC}{OC}=\frac{\sin DOC}{\sin OCD} \quad (3)$$

and $$\frac{DB}{OB}=\frac{\sin DOB}{\sin OBD} \quad (4)$$

Dividing (1) by (2) and (3) by (4), and multiplying the quotients and cancelling common factors, we get $\frac{\sin AB}{\sin AC}\times\frac{\sin DC}{\sin DB}=\frac{AB}{AC}\times\frac{DC}{DB}$. The right side of the equation is the geometrical analogue to $\begin{matrix}h\,k\,l\\h'k'l'\\p\,q\,r\end{matrix}\times\begin{matrix}p'q'r'\\p\,q\,r\\h'k'l'\end{matrix}$ of the sine formula, the identity of which with the ratios of the sines of the angles requires a very elaborate proof and is lucidly stated by the Cambridge crystallographer, Prof. C. Lewis.[3]

If we express the left side of the sine formula as $\frac{\sin AB}{\sin AC}\times\frac{\sin (AD-AC)}{\sin (AD-AB)}$ thereby eliminating DC and DB, and put the product of the right side of the equation $=\frac{d}{q}$, then by expanding the left side and dividing it by sine AB sin AC sin AD, we get,

$$\frac{\cot AC-\cot AD}{\cot AB-\cot AD}=\frac{p}{q},$$

which by cross-multiplication and transposition becomes $p \cot AB - q \cot AC=(p-q)\cot AD$. In harmonic cases the value $\frac{p}{q}=\frac{1}{2}$; substituting $p=1$ and $q=2$ in the above formula and transposing, it simplifies to

$$\cot AB+\cot AD=2\cot AC.$$

Mysore University, P. R. J. NAIDU.
Central College,
June 27, 1949.

1. Tutton, A. E. H., "Crystallography and Practical Crystal Measurement," 1922, I, p. 89. 2. Barker, T. V., "Graphical and Tabular Methods in Crystallography," 1922, p. 61. 3. Lewis, W. J. "Crystallography," 1899, pp. 87-93.

BEREK'S COMPENSATER

IN a note on Berek's compensater,[1] a correction was made that log f (i) values should be used instead of log (i) values. The log f (i) values are computed from the formula of Berek :—

$$\log f(i)=\log \sin^2 i\{1+\cdot 2040\sin^2 i+\cdot 0627\sin^4 i\}.$$

Substituting the values of (i), in the case of hypersthene, *viz.*, 14·55° and 24·95° in the equation, it is seen that the values of log f (i) for these angles correspond to 8·806 and 9·266 as given in the tables. The proof of this correction factor is given, after Berek,[2] as follows:—

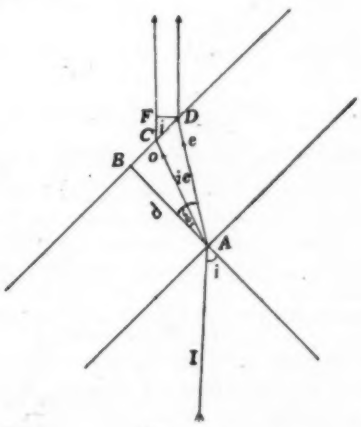


FIG. 1

The incident ray (I) is refracted in the calcite plate into the rays o and e, which on emergence from the plate, are parallel ; and at the point D, o has travelled the distance AC + CF, and e the distance AD. Therefore,

$$\Gamma=\frac{AC}{\lambda_1}+\frac{CF}{\lambda}-\frac{AD}{\lambda_2} \quad (1)$$

If d be the thickness of the plate

$AC = \frac{d}{\cos i_0}$; $AD = \frac{d}{\cos i_e}$; $CF = d\ (\tan i_e - \tan i_0) \sin i$. We also know that $\omega\lambda_1 = \epsilon_1\lambda_2 = \lambda$, and $\omega \sin i_0 = \epsilon_1 \sin i_e = \sin i$. Substituting these values in (1) above, we have,

$$\Gamma = \frac{\omega d}{\lambda \cos i_0} + \frac{d}{\lambda}\left(\frac{\epsilon_1 \sin^2 i_e}{\cos i_e} - \frac{\omega \sin^2 i_0}{\cos i_0}\right) - \frac{\epsilon_1 d}{\lambda \cos i_e} = \frac{d}{\lambda}(\omega \cos i_0 - \epsilon_1 \cos i_e). \quad (2)$$

But we know from the index ellipsoid of a uniaxial crystal that $\frac{1}{\epsilon_1^2} = \frac{\cos^2 i_e}{\omega^2} + \frac{\sin^2 i_e}{\epsilon^2}$, and that $\epsilon_1^2 \sin^2 i_e = \sin^2 i$. From these two relationships, it is proved that $\epsilon_1^2 \cos^2 i_e = \omega^2\left(1 - \frac{\sin^2 i}{\epsilon^2}\right)$ and that $\omega^2 \cos^2 i_0 = \omega^2\left(1 - \frac{\sin^2 i}{\omega^2}\right)$. Inserting these values in (2) above, we have,

$$\Gamma = \frac{d}{\lambda}\,\omega\left(\sqrt{1 - \frac{\sin^2 i}{\omega^2}} - \sqrt{1 - \frac{\sin^2 i}{\epsilon^2}}\right).$$

Solving this last expression by the binomial theorem, we get,

$$\Gamma = \frac{d\omega}{2\lambda}\left(\frac{1}{\epsilon^2} - \frac{1}{\omega^2}\right)\sin^2 i \left\{1 + \frac{1}{4}\left(\frac{1}{\epsilon^2} + \frac{1}{\omega^2}\right)\sin^2 i + \frac{1}{8}\left(\frac{1}{\epsilon^4} + \frac{1}{\epsilon^2\omega^2} + \frac{1}{\omega^4}\right)\sin^4 i + \ldots\right\} \quad (3)$$

Inserting the values of ϵ and ω of calcite, the expression within the $\{\ldots\}$ bracket in (3) above simplifies into $\sin^2 i\ \{1 + \cdot 2040 \sin^2 i + \cdot 0627 \sin^4 i\}$, which is the factor indicated as $f(i)$ in the tables; and the first part of (3), i.e., $\frac{d\omega}{2\lambda}\left(\frac{1}{\epsilon^2} - \frac{1}{\omega^2}\right)$ is indicated as constant C in the tables. Both these values can therefore be calculated, if the tables are lost.

Central College, P. R. J. NAIDU.
Mysore University,
June 22, 1949.

1. *Curr. Sci.*, Feb. 1949, **18**, No. 2, 43 and *Ibid.*, Apr. 1949, No. 4, 144. 2. von Dr. M. Berek, "Mikroskopische Mineralbestimmung mit Hilfe der Universal drehtiseche methoden," 1924, 133-36.

MAGMATIC WATER IN CHALCEDONY AND AGATE, BHERA GHAT, JUBBULPORE DISTRICT, CENTRAL PROVINCES

THE author came across very interesting nodules of chalcedony and agate containing magmatic water while touring the interesting and celebrated area of the Marble Rocks of Bhera Ghat in the Jubbulpore District of the Central Provinces. So far he is aware no such instance has been recorded from India before. It has been, therefore, deemed advisable to place it on record. He came across a nodule of chalcedony, about 1¼ inches in size and with the maximum thickness of half an inch. One side of the nodule was convex in shape, while the other side was plane. It was observed to contain magmatic water which appeared to move inside the nodule when it was rotated. At first it was taken for some light effect. But on breaking the nodule it was found to contain water which splashed on all sides. Inside the nodule a cavity or rather a fine geode was observed, which measured three-fifths of an inch in width and one-fifth of an inch in height. Fine crystals of quartz, slightly bluish in tinge, were found lining the cavity. The trapped water was apparently a hydrothermal solution containing silica, which was responsible for the crystallisation of quartz inside the fine geode.

On enquiry the author was informed that such nodules of chalcedony and even agate are commonly found in the bed of the Narbada. A search for such nodules containing water is made by the local people in the bed of the stream. These are cleaned and somewhat polished in order that the enclosed water becomes visible, particularly on rotating the nodule. Occasionally, large nodules are found which may contain one tola or two-fifths of an ounce of such magmatic water. Such nodules are purchased by the pilgrims and other tourists as souvenirs from the Narbada at Bhera Ghat. It would be interesting to recover the trapped magmatic water and analyse it chemically.

The origin of this magmatic water is definitely connected with the igneous activity which was responsible for the instrusions of the basic dykes in the marble rocks. On microscopic examination these dykes have proved to be of olivine gabbro, quartz-hypersthene-biotite-gabbro, and epidiorite. These dykes appear no doubt to be the

hypabyssal representatives of the Deccan Trap flows of which occur near Jubbulpore and also across the Narbada near Tilwara Ghat. It appears that the hydrothermal phase of this igneous activity was represented by the water containing silica in solution. It deposited silica as quartz, chalcedony, agate, opal, jasper, etc., in the form of intricate veins and patches so commonly observed in the dolomitic marble. On weathered surfaces of the marble the beauty and the intricacy of the patterns of this silica becomes clear.

With regard to these nodules it appears that the crystallisation of this silica begins from the exterior and sometimes as a result of rapid chilling the solution gets entrapped which for sometime lays a deposit of crystals of quartz, fine or large according to the size of the cavity and the amount of solution enclosed.

The author[1] has published already an account of the occurrence of magmatic water in the Deccan Trap.

Benares Hindu University, H. L. CHHIBBER.
May 27, 1949.

---

1. Chhibber, H. L., *Curr. Sci.*, 1946, **15**, 41-42.
2. —, *Proc. Ind. Sci. Cong.*, 1945.

ELECTROLYTIC PREPARATION OF AZO-DYES. III. DYE FORMATION AT AN IRON ANODE

AZO-DYES are formed at the anode in an electrolytic cell but only with low yields. The probable reasons for this have been discussed in an earlier communication[1] and can be seen to be unavoidable under the circumstances. It was therefore considered worthwhile to try to improve the yield of the dye by other methods, or at least to try to get this method of preparing azo-dyes to be practicable in some way or other. One step that suggests itself is the elimination of platinum as anode material. If this were done, the advantage gained would be twofold. Firstly, the use of an expensive metal is avoided. Secondly, nitrites are oxidised to nitrates at a platinum anode, especially when the alkalinity of the anolyte is low.[2] While it has been observed that the presence of nitrate ion is not harmful in itself, it would certainly be reasonable to take care to see that as little of the nitrite taken is oxidised especially in view of the fact that the dye formation proceeds better on prolonged electrolysis.

The platinum anode could therefore be replaced profitably by an anode which is in the first place quite cheap and secondly is a poor oxidiser for nitrite. The materials that satisfy the first condition are carbon, iron and nickel. Iron and nickel also satisfy the second requirement for nitrite is oxidised with a very low efficiency at anodes of iron and nickel.

A series of experiments carried out with these materials showed that only iron was suitable for use as anode. It was found that carbon anodes disintegrated badly, though some dye formation took place. Nickel anodes also had to be rejected, since extensive tar formation occurred, and the formation of the dye was very poor. Iron had none of these defects and was corroded only to a negligible extent, particularly when a heavy sheet was used, with the corners and edges rounded off by filing.

Several dyes were prepared by electrolysis of the proper components at an iron anode. The yields obtained were comparable to those obtained at a platinum anode, and in some instances slightly better.

EXPERIMENTAL

The cell used in this series of experiments was of the divided type, a porous alundum cup forming the cathode chamber and diaphragm. The anode was of heavy sheet iron, with the edges and corners rounded by filing. This anode was cleaned, heated to redness and chilled in water before being used, as the reaction was found to be unsatisfactory without this treatment. It would perhaps be better to refer to this anode as an iron oxide anode; the thin layer of oxide formed might help the passivation of the anode. The entire arrangement was kept in a 400 c.c. Pyrex beaker, which formed the anode chamber. A glass propeller type stirrer was used for stirring.

Roccelin: 3·06 gm. sodium naphthionate, 1·80 gm. β-naphthol, 0·87 gm. sodium nitrite and 0·50 gm. sodium hydroxide, in 150 c.c. of water were electrolysed for 20 minutes at a current density of 5 amps./dm.^{2} The anolyte was coloured a deep red. The dye was salted out by carefully adding 20 gm. of sodium chloride with good stirring. The precipitated dye was filtered at the pump, washed with dilute sodium chloride solution, sucked as dry as possible and dried in the air-oven. A dark red powder that was indis-

tinguishable from the dye obtained at the platinum anode was got. Silk dyed with this sample had a good colour. Yield of dye: 1·10 gm. or 22% of the theoretical.

Orange II: This dye was also formed in a satisfactory manner at an iron anode. 2·50 gm. sulphanilic acid, 1·80 gm. *6*-naphthol, 0·50 gm. sodium hydroxide, and 1·00 gm. sodium nitrite, in 150 c.c. of water were electrolysed for the theoretical length of time, at a current density of 5amps./dm.^{2} The dye was recovered as the barium salt. Yield of dye: 1·48 gm. or 29·6% of the theoretical.

On passing the current for thrice the theoretical length of time, a better yield of dye was obtained: 3·07 gm. or 61·4% of the theoretical.

Ponceau G: This dye was obtained by the electrolysis of molar proportions of aniline, 2-naphthol-3, 6-disulphonic acid (disodium salt) and sodium nitrite in an alkaline electrolyte. The dye was formed in very poor amounts in neutral medium. 4·35 gm. R-salt, 1·16 gm. aniline, 0·90 gm. sodium nitrite and 0·50 gm. sodium hydroxide, in 150 c.c. of water were electrolysed at a current density of 5 amps./dm.^{2} for 20 minutes. The anolyte had a bright red colour. The dye was recovered from the anolyte by salting out. The precipitated dye was filtered at the pump, dried and weighed. Yield of dye: 1·15 gm. or 20·3% of the theoretical. The colour on silk and wool was bright and of a good shade.

On passing the current for thrice the theoretical time, the yield of dye improved, and amounted to 3·4 gm. or 60·2% of the theoretical. The current efficiency is seen to be the same, that is, 20%.

Ponceau 2R: This dye could also be prepared by the electrolytic method using an iron anode. In this case, a study was made of the effect of factors like the addition of sodium nitrate, the change in the alkalinity of the anolyte and prolonged electrolysis. The formation of the dye at a platinum anode under what appeared to be the most favourable conditions was also studied. The results are summarised in the table below. 4·35 gm. R-salt, 1·50 gm. *m*-xylidine and 0·90 gm. of sodium nitrite were electrolysed in 150 c.c. of water, with the modifications mentioned above, at an iron anode. The current density was 5 amps./dm.^{2} The anolyte was coloured a dark red at the end of the run. The dye was precipitated from solution on the addition of 25 gm. of sodium chloride with good stirring. The precipitated dye was then filtered at the pump, sucked nearly dry, dried in the air oven at 80° C. and weighed. The quality of the dye was judged as usual by comparative dyeing tests and found to be quite satisfactory.

TABLE

Yield of Ponceau 2 R under Different Conditions of Electrolysis

Addition Agent	Weight gm.	Duration of Run (mins.)	Yield of Dye. gm.	Efficiency	
				Material	Current
None	..	20	..	..	..
$NaNO_3$	1·65	60	2·30	38·0%	12·6%
NaOH	0·50	60	2·65	44·2%	14·7%
*NaOH + $NaNO_3$	1·65 + 0·50	60	2·75	46·6%	15·3%
NaOH + $NaNO_3$	1·65 + 0·50	120	5·73	95·5%	15·9%
*Iron Anode			2·75	46·6%	15·3%
Platinum Anode			2·30	38·0%	12·6%

The following interesting observations can be made from this table. The dye formation proceeds only in an alkaline electrolyte and better when sodium nitrate is added; the yield in this is seen to be maximum. The presence of nitrate does not cause corrosion of the anode. The yield of dye amounted to 95·5% of the theoretical if the electrolysis went on for 2 hours, or six times the theoretical duration. The current efficiency for a given set of conditions, appears to be independent of the concentration of the reactants, since the yield is quantitative if the electrolysis is prolonged for a sufficient length of time, which is almost an exact multiple of the theoretical time.

Presidency College, M. V. SITARAMAN.
Madras, V. V. RAMAN.
April 20, 1949.

1. Sitaraman, M. V., and Raman, V. V., *Curr. Sci.*, 1948, **17**, 234; 1949, **18**, 44. 2. Traube, *et al.*, *Ber.*, 1904, **37**, 3130; 1905, **38**, 823; 1906, **39**, 166. 3. Foerster, *Elektrochemie*, 1922, 812.

SURFACE TENSION OF SOLUTIONS OF CETYL PYRIDINIUM BROMIDE

ADAM AND SHUTE[1] have observed that the surface tension of dilute aqueous solutions of cetyl pyridinium bromide falls with time, attaining a final equilibrium surface tension, which is independent of the concentration. The rate of fall is very slow in dilute solutions and rises as the concentration increases until above a certain concentration the equilibrium is very quickly attained,

The idea presented here is very similar to Doss and Rao's[2] idea on the wetting of solids by liquids. It has been assumed that only a certain fraction of the surface is occupied by cetyl pyridinium bromide molecules in dilute solutions. As the concentration increases the fraction of the surface occupied by cetyl pyridinium bromide molecules also increases. When surface is allowed to age, molecules from the bulk of the solution come to the surface, taking time to work against the inward molecular forces. There is, however, a concentration at which the whole of the surface is covered by cetyl pyridinium bromide molecules and consequently the equilibrium is attained very quickly. Above this concentration probably micelle formation occurs and the surface tension remains unaltered.

The fraction of surface can be represented by,

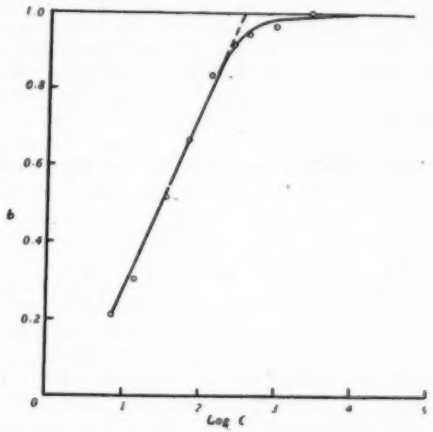
$$\sigma = \frac{\gamma_{H_2O} - \gamma}{\gamma_{H_2O} - \gamma_E}$$

where γ_{H_2O} = surface tension of water,
γ = Semi dynamic surface tension[3] (*i.e.*, surface tension of solution before ageing commences)
γ_E = Equilibrium surface tension.

The measurement of surface tension was carried out by a Cenco-du Noüi tensiometer at 25° applying correction as suggested by Harkins and Jordan.[4] The values are given in the table below:

The equilibrium surface tension of 36 dynes/cm. was in agreement with Adam[5] and Brown.[6]

In Fig. 1, the fraction of surface σ is plotted against the logarithm of concentration in milligrams per litre. By extrapolating the lower part of the curve to the line $\sigma = 1$, the concentration, at which the number of cetyl pyridinium bromide molecules is just sufficient to cover the whole of the surface is obtained. At this concentration ageing of surface becomes quick. The concentration of 0·034% is in agreement with Adam's value of 0·04%



where slow fall of surface tension is abolished. The point at which the lower part of the curve deviates from the straight line gives us the concentration of 0·022% at which micelle formation begins. The concentration at which micelle formation begins is 0·028% from conductivity measurements. It, therefore, seems that micelle formation commences before the whole of the surface is covered by single cetyl pyridinium Bromide molecules.

My grateful thanks are due to Dr. M. R. A. Rao for kind advice.

Dept. of Pure & App. Chem., B. K. Banerji.
Indian Institute of Science,
Bangalore,
June 23, 1949.

Values of semi-dynamic surfaces tension and fraction of surface occupied by cetyl Pyridinium bromide molecules at different concentrations

Conc. mg./litre ..	2786	929	398	253	132	68	34·4	13·96	6·96
Semi-dynamic surface tension dynes/cm.	36·0	37·5	38·0	39·2	42·0	48·0	53·5	61·1	66·5
σ ..	1·0	0·96	0·94	0·91	0·83	0·66	0·51	0·30	0·21

1. Adam and Shute, *Trans. Farad. Soc.*, 1938 **34**, 758. 2. Doss and Rao, *Proc. Ind. Acad. Sci.*, 1938, **7**, 113. 3. Ross, *J. Phys. Chem.*, 1945, **49**, 377. 4. Harkins and Jordan, *Jour. Am. Chem. Soc.*, 1930, **52**, 204. 5. Adam, *Trans. Farad. Soc.*, 1935, **31**, 204. 6. Brown, *Proc. Phys. Soc.*, 1936, **48**, 312.

ADVERSE EFFECT OF MIXING TAPIOCA AND SWEET POTATOES IN WHEAT FLOUR

FOR overcoming the food shortage in the country, the Ministry of Food has recommended the mixing of tapioca and sweet potatoes meal in wheat flour. This scheme while calculated to increase of food supply of the country, is likely to produce an adverse effect on the health of the nation, which is already suffering from an ill-balanced diet.

For religious and economic reasons animal proteins (meat, fish and eggs) are ruled out from the diet of a good percentage of the people. The intake of dairy products is very low in our country, the *per capita* consumption of dairy products in India being about one-tenth of Canada and Newzealand, one-eighth of Great Britain and one-seventh of U.S.A.[1] Due to ill-balanced diet, the people are undernourished and are afflicted by many diseases. Shortage of good quality proteins and the B-vitamins are the two outstanding nutritional deficiencies in the cereal diet of the masses. Addition of some food rich both in good quality proteins and vitamins of the B-complex is necessary for balancing the cereal diet.

TABLE I

Chemical Analysis of Some Foods

Percentages

Foods	Protein	Fat	Carbo-hydrate	Moisture	Ash
Wheat (whole)	13·0	2·0	72·4	11·0	1·6
Sweet potatoes	1·8	0·7	27·9	68·5	1·1
Tapioca	0·6	0·2	86·4	12·6	0·2
Food Yeast (*Torula utilis*)	48·0	2·0	24·0	8·0	8·0

As evident from Table I both tapioca and sweet potatoes are rich in carbohydrates which is principally starch. The addition of these starchy foods to wheat flour would render it ill-balanced. The resulting mixture will have less protein and fat and much more carbohydrate. These changes in protein, fat and carbohydrate contents will be proportional to the quantity of tapioca or sweet potatoes incorporated. Thus though the caloric intake of food will be increased due to the added carbohydrate there will be a marked fall in the percentage of the protein, and is likely to be a more widespread incidence of the deficiency diseases in the country.

In order to make this scheme practicable, the proposed mixture will have to be fortified with good quality proteins and the vitamins of the B-complex. As evident from Table I dried food yeast contains about 50% proteins of high nutritive value. Also yeast is a very rich source of B-vitamins. It can be added upto 5% to the flour, without any detectable change in taste and appearance of the product.

Food yeast can be easily produced in India either from molasses—a by-product of the sugar industry or from bassia flowers or from cellulosic waste materials such as wood, straw, stalks, husk, bagasse.

It is hoped that the Ministry of Food will reconsider their proposal and modify their scheme in the light of what has been presented in this note.

Chitti-Khana, P. N. AGARWAL.
Agra, U.P.,
June 5, 1949.

1. "Report on the Marketing of Milk in India and Burma", Government of India Press, Simla, II Edition, 1943. 2. Peterson, W. H., Skinner, J. T., and Strong, F. M., "Elements of Food Biochemistry," Prentice Hall, Inc., New York, 1944 Edition. 3. Walker, R. D. (Jr.), *Technical Paper* No. 16, *Florida Engineering and Industrial Experiment Station, Florida.*

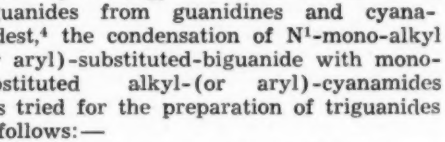
ATTEMPTS TOWARDS THE SYNTHESIS OF SUBSTITUTED POLYGUANIDES

ON the basis of their observations, Curd and Rose[1] put forward the hypothesis that for antimalarial activity, the aromatic ring and the basic side chain should be linked through a system of alternate carbon and nitrogen atoms with appropriate double bonds; they also argued that the "tautomeric possibilities existing within certain known active drug molecules" relate to the antimalarial activity. Paludrine, satisfying all the above conditions, has been claimed to be one of the best antimalarials obtained so far.

With this background, it was thought worthwhile to prepare compounds with a larger number of these conjugated system of carbon and nitrogen atoms, expecting that such compounds might prove to be better and more effective antimalarials. The polyguanides, such as tri-, or tetra-guanides or even the higher members are to provide more of the tautomeric possibilities and such other factors. This postulation was also supported by our observation that the monoguanide derivative with p-chlorophenyl- and isopropyl groupings present at the two ends, (*viz.*, N^1-p-chlorophenyl-N^3-isopropyl-

guanidine acetate[2]), as in paludrine, was found to possess no antimalarial activity and was also found to be too toxic.[3]

Various methods were tried for the preparation of these compounds which are really biguanides lengthened further by the addition of one or more of guanidine residues. By analogy with the formation of biguanides from guanidines and cyanamidest,[4] the condensation of N^1-mono-alkyl (or aryl)-substituted-biguanide with mono-substituted alkyl-(or aryl)-cyanamides was tried for the preparation of triguanides as follows:—

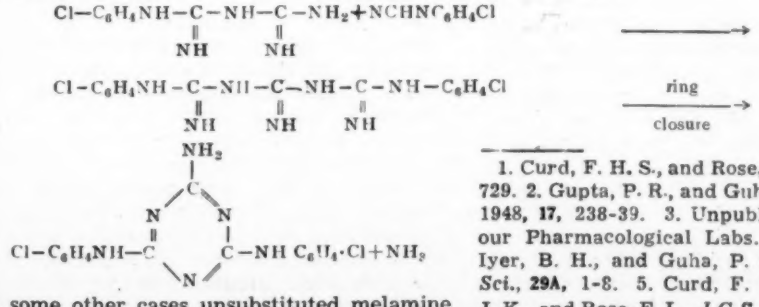


where R and R′ = CH_3—, β—OHC_3H_4—, iso C_3H_7—, *p*-cl-C_6H_4—, etc.

The condensation was tried under varying conditions of experiments, *viz.*,

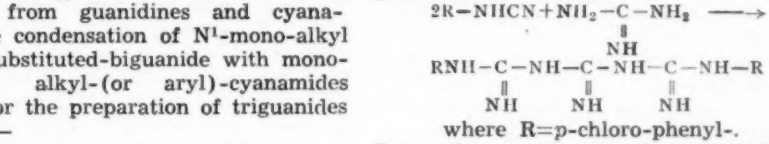
(*a*) In acidic, neutral or basic medium in alcoholic solution;
(*b*) In presence of pyridine or dioxane;
(*c*) Under ordinary pressure or under pressure in closed vessels.

From the reaction products of none of these experiments, the desired triguanides could be isolated; in one particular instance, however, when the reaction was tried with *p*-chlorophenyl-biguanide and *p*-chlorophenyl-cyanamide in a closed vessel in alcoholic medium, ammonia came out profusely on opening the soda-water bottle, in which the reaction was conducted; and on working out the reaction product 2-amino-4 : 6-di-*p*-chloro-anilino-1 : 3 : 5-triazine-hydrochloride,[5] (m.p. 284-85°; Nitrogen found: 22·36% $C_{15}H_{12}N_6Cl_2$, HCl requires 21·92) was isolated, which was evidently formed, from the triguanide, first formed, by ring closure, as follows:—



In some other cases unsubstituted melamine was obtained, which was crystallised from water in fine needles, m.p. 213° C. (Nitrogen found: 66·82%; $C_3H_6N_6$ requires 66·6%.) The substituents were all knocked off during the process.

The synthesis was next tried by the condensation of two molecules of mono-substituted cyanamide with a molecule of guanidine as follows:—



where R=*p*-chloro-phenyl-.

From the reaction product no triguanide could be isolated but a compound having an m.p. of 253-55° C. and containing 16·85% nitrogen was isolated.

Lastly, with the same object, the condensation of N^1-p-Cl-phenyl-N^3-cyanoguanidine with N^1-isopropyl-guanidine (either as a base or its salt) was also tried, but eventually some compound other than the triguanide could only be isolated. The substance was crystallised in shining flakes from 95% alcohol. It had an m.p. of 174° C. and contained 15·8% of nitrogen.

In most of the cases, very viscous semi-solid mass was formed which solidified only after a few days' standing. The exact nature and characterization of the compounds which were isolated during the investigation, as also other methods of synthesis are now being studied and will be published at a later date.

Authors' thanks are due to the Indian Research Fund Association for the award of a research fellowship to one of us (P. R. G.).

P. R. GUPTA.
P. C. GUHA.

Organic Chem. Lab.,
Indian Institute of Science,
Bangalore,
June 4, 1949.

1. Curd, F. H. S., and Rose, F. L., *J.C.S.*, 1946, 729. 2. Gupta, P. R., and Guha, P. C., *Curr. Sci.*, 1948, **17**, 238-39. 3. Unpublished result from our Pharmacological Labs. 4. Bami, H. L., Iyer, B. H., and Guha, P. C., *Jour. Ind. Inst. Sci.*, **29A**, 1-8. 5. Curd, F. H. S., Land quist, J. K., and Rose, F. L., *J.C.S.*, 1947, 154-60.

ESTIMATION OF ACETIC ACID IN PYROLIGNEOUS LIQUORS

THIS paper outlines a fairly accurate and rapid method for the estimation of acetic acid in pyroligneous liquors.

Attempts have been made to remove the dark colour of the liquor and eliminate constituents which blacken on addition of alkali, by bleaching with animal charcoal,[3] extraction,[10] distillation[5,6,7,7,8,11,12] distillation with extraction,[1] or neutralising the acid mixture with barium hydroxide and evaporation to dryness.[8] All of these procedures are lengthy and require some sort of special apparatus. Acid is usually incompletely recovered in case of distillation methods. In the present method the liquor is purified by oxidation with permanganate in alkaline solution.

In most of the methods the purified liquor is titrated using phenolphthalein as indicator and the result reported as acetic acid. It is obvious that this procedure gives the total acidity and not the acetic acidity. In the proposed method the liquor after oxidation is acidified with sulphuric acid to liberate acetic acid and by potentiometric titration acetic acid can be estimated in a mixture of acetic and sulphuric acids. Potentiometric titration can be replaced by ordinary titration using tropeolin OO or methyl violet as indicators.[4,9] Methyl violet has been tried by the present authors.

EXPERIMENTAL

Test samples were prepared by boiling 200 gm. of settled wood tar with 400 ml. of water for an hour and filtering when cold. To one ml. of the filtrate was added 2 ml. of acetate test solution[2] and excess NaOH and the whole brought to a boil. Absence of a green precipitate indicates absence of acetic and formic acid. Filtrate is now acidified with known amounts of acetic, formic, butyric and propionic acids and the volume made up to 1,000 ml.

5 ml. of the sample is pipetted in an Erlenmeyer flask and diluted to 200 ml. Excess alkali is added till the liquor is distinctly brown. About 15 gm. of permanganate crystals are added and the solution is heated over water-bath for two hours with constant shaking. Permanganate must still show in excess. After oxidation the liquor is allowed to cool and excess permanganate is taken up by hydrogen peroxide. The supernatant liquid will now be perfectly clear. If subsequently potentiometric titration is to be carried out the liquor is filtered and the filtrate received in 250 ml. beaker. If methyl violet titration method is to be followed, a 500 ml. Erlenmeyer flask will be more convenient. The precipitate is washed free of all acetate as is shown by the absence of a green precipitate on addition of the test solution.[2] After washing and reduction in volume to the desired extent all the filtrate is acidified with sulphuric acid till clear excess of the later is present. The solution can now be potentiometrically titrated to indicate sulphuric and acetic content separately. Alternatively a small quantity of methyl violet is added to the acidified liquor and titrated till the colour changes from blue to violet. This is noted as the end point for sulphuric acid. Titration is completed using phenolphthalein as indicator. Difference between the burette reading now and at the sulphuric neutralisation point gives a value for acetic acidity. Alkali used should be preferably N/10. Results of the experimental work are given in the following table:—

Sample No.	Non-oxidisable acids in ml. of NaOH required for titration			Titration reading for oxidised acidified liquor in ml. of NaOH		Acetic acid by difference between 5 and 6	Percentage error in estimation of acetic acid
	Acetic	Butyric	Propionic	Methyl violet titration	Phenolphthalein titration		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	29·00	0·109	0·126	14·9	44·1	29·2	0·69
2	36·25	,,	,,	12·6	49·2	36·6	0·70
3	43·50	,,	,,	19·2	62·91	43·71	0·48
4	50·75	,,	,,	27·3	78·2	50·90	0·31
5	58·00	,,	,,	8·6	66·84	58·24	0·26

All of the above samples contained formic acid equivalent to 7·9 ml. of NaOH.

CONCLUSION

Whether purification is done by extraction or by distillation of the liquor it is necessary to free the distillate or the extract of its small quantities of soluble tar, formic acid, etc., by permanganic oxidation. In the proposed method therefore, the procedure has been cut short by conducting only the oxidation. Not only is the need for a special distillation or extraction apparatus avoided but a better clarification in a shorter time and with less attention can be obtained.

Loss of acid is also minimised. After oxidation, a further distillation is not necessary according to the present method. This is a decided advantage over Grotlisch's method.[1]

The results of the table show that propionic and butyric acids get estimated as acetic. But this is so with other methods also. Although Grotlisch claims that butyric acid does not appear in the final distillate in his method the claim appears doubtful. As a matter of fact the proportions of these acids in the liquor are small enough not to affect the acetic acid estimation to any appreciable extent.

Laxminarayan Institute, Nagpur, C.P., India,
May 30, 1949.

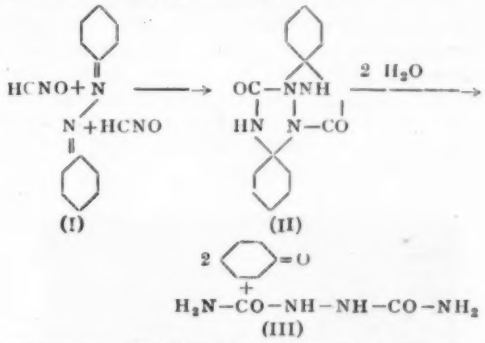
P. S. MENE.
U. R. WARHADPANDE.

1. Grotlisch, V. E., *Ind. Eng. Chem.*, 1920, **12**, 1183. 2. Prescott and Johnson, "Qualitative Chemical Analysis," 7th ed. p. 258. 3. Sergeeva, A. M., *C. A.*, 1942, **36**, 3660. 4. Fuchs, Paul, *Ibid.*, 1943, **37**, 3370. 5. Griffin, "Technical Methods of Analysis," McGraw Hill Co, p. 496. 6. Mouratoff, C., *C. A.*, 1946, **40**, 2418. 7. Fuchs, Paul, *Ibid.*, 1946, **40**, 7080. 8. Weihe and Jacobs, *Ind. Eng. Chem., Anal. Ed.*, 8-44-7, 1936. 9. Duchemin and Criquebeuf, *C. A.*, 1907, **1**, 1676. 10. Onoderia, Isonosuke, *Ibid.*, 1921, **15**, 1675. 11. Allen's "Commercial Organic Analysis," 5th Ed., **1**, 690. 12. Heuser, E., *C. A.*, 1915, **9**, 1444.

CRISSCROSS ADDITION TO HYDROAROMATIC KETAZINES

WITH conjugated systems of double bonds addition generally takes place at 1, 4 or 1, 2 positions.[1,2,3] However, conjugation between carbon and nitrogen, like $>C=N-N=C<$ as in azines, shows some peculiarities in addition reactions and Bailey, *et al.*, discovered a number of cases of 1,3—2,4 coupled-addition by the azine system.[4,5] This type of reaction was named "Crisscross Addition" by Bailey and McPherson.[5] A number of such additions with the azine system were subsequently observed.[6,7]

All these observed cases of crisscross addition are, however, confined to aldazines and now the reaction has been extended to ketazines for the first time. Azines of hydroaromatic ketones add two molecules of cyanic acid in acetic acid below 10° C. with surprising ease, giving sharp melting, crystalline solids. The addition products have been proved to be bitriazole compounds (II) by hydrolytic degradation to hydrazodicarbonamide (III); the course of reaction being as follows:



Crisscross addition of cyanic acid to cyclohexanone azine and 2-methyl and 4-methyl cyclohexanone azines gives the corresponding bitriazoles melting at 210°, 219° and 228·5° C. respectively.

The hydroaromatic ketazines also react with thiocyanic acid, maleic anhydride and α-naphthoquinone with the same ease, giving crystalline adducts. Work is in progress towards settling the structure of the addition products.

Organic Chem. Laboratories,
Department of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore,
July 22, 1949.

D. B. DUTT.
P. C. GUHA.

1. Thiele, *Ann.*, 1899, **305**, 87. 2. Michael, *J. pr. Chem.*, 1899, **60**, 437. 3. Erlenmeyer, *Ann.*, 1901, **316**, 43. 4. Bailey and Moore, *J. Amer. Chem. Soc.*, 1917, **39**, 278. 5. Bailey and McPherson, *ibid.*, 1917, **39**, 1322. 6. Wagner-Jauregg, *Ber.*, 1930, **63**, 3213. 7. Van Alphen, *Rec. trav. Chim.*, 1942, **61**, 892.

EMBRYO CULTURE TO OBTAIN F, PLANTS OF INCOMPATIBLE CROSSES IN CORN (MAIZE)

IN wide crosses, as a rule, in nearly all the ovules, after a definite period from the time of pollination, the endosperm begins to collapse. Shortly thereafter the embryo too collapses as its growth thereby gets arrested (Blakeslee and Satina, 1944). Occasionally in the hybrid one or more ovules may be found which are almost comparable with

those of the same age in a normal plant. These are usually only partially filled and ordinarily responds to embryo culture when young, while it is noticed that germination is very poor for these seeds when mature. The object of this experiment is to compare the germination by embryo culture of such immature partially filled seeds against that by the ordinary method of pot sowing, of such but mature seeds from incompatible crosses like a diploid × tetraploid or a triploid × tetraploid, in corn.

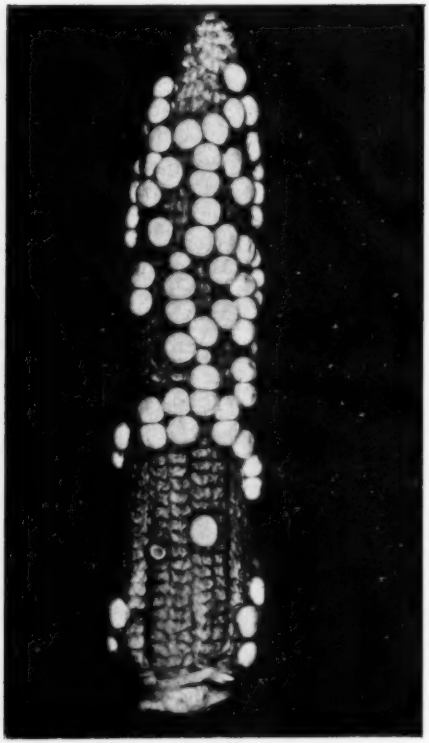


FIG. 1

A 2-Week old corn ear obtained by crossing a tetraploid female parent with a triploid male parent. Notice the different types of grains showing the fully filled, partially filled and the unfilled grains.

Out of the 13 diploid × tetraploid crosses, that were made, 66 partially filled seeds were obtained. These seeds when pot sown, gave only 15 plants of which one turned out to be a triploid, the others showing varying numbers of chromosomes from 28 to 33. Chromosomes were counted from root tips prepared by the usual paraffin section method, using crystal violet for staining.

Since as a rule, the embryos of the mature partially filled seeds of wild crosses do not germinate even under embryo culture, the embryo having already collapsed beyond the pro-embryo stage, an estimate of successful germination in a wide cross by embryo culture method, has to be attempted at an early stage of embryo development. With this end in view, the above triploid was crossed to a tetraploid.

In this cross between the triploid as the male parent and tetraploid as the female, it was observed that when the ovules were two weeks old, there were three distinct classes of kernels (Figure 1). They

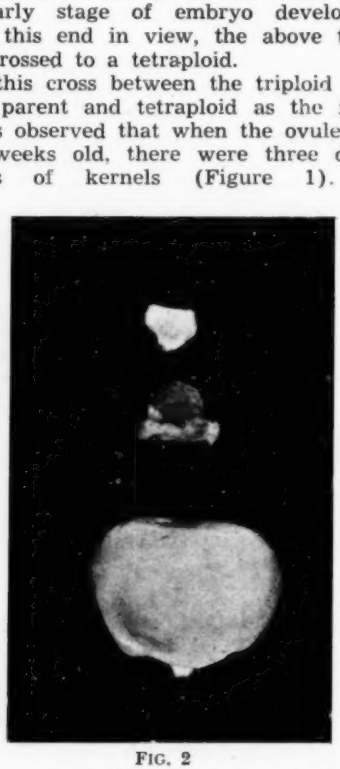


FIG. 2

Photograph of the 3 types of grains indicated in Fig. 1

were (1) full round normal kernels, (2) partially filled small-sized kernels and (3) very small unfilled kernels (Figure 2). Evidently the last class represents the unfertilized ovules. The semi-filled and the intermediary sized kernels represent the real hybrid seeds. The counts made of kernels belonging to these three classes showed a ratio of 104 : 3 : 532. The ovules of the three hybrid kernels, when 16 days old, were dissected out and the embryos cultured in the Tukey's medium (Tukey, 1934) plus growth-promoting substances (Van-Overbeek and others, 1941). All the three

embryos grew into seedlings. The chromosome counts from the root tips revealed them to be heteroploids with chromosome numbers ranging above and below the triploid number.

It may be recalled here that out of the 66 partially filled tetraploid × diploid crosses that were shown in pots only 15 germinated. Thus it will be seen that the percentages of germination by the ordinary method of sowing and by embryo culture at a very early stage of seed development, work out to be 23 and 100 respectively in this case. Embryo culture of very young seeds in this way helps to secure a greater percentage of F_1 plants out of incompatible crosses than by the ordinary method of germination of these seeds when ripe by pot sowing.

Agri. Res. Institute. P. UTTAMAN.
Coimbatore,
July 15, 1949.

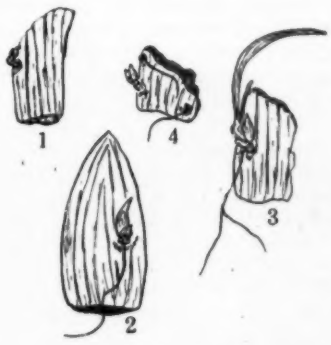
1. Blakeslee, A. F., and Satina, S., "New hybrids from incompatible crosses in Datura through culture of excised embryos on malt media," *Science*, 1944, **99**, 331-34. 2. Van-Overbeek, Marie E. Conklin and Blakeslee, A. F., "Factors in coconut milk essential for growth development of very young Datura embryos," *Science*, 1941, **94**, 350-51. 3. Tukey, H. B., "Artificial culture methods for isolated embryos of deciduous fruits," *Pro. Amer. Soc. Hort. Sci.*, 1934, **32**, 313-22.

A NOTE ON THE VEGETATIVE PROPAGATION OF *LILIUM LONGIFLORUM* WALL.

Lilium longiflorum Wall. belongs to the family Liliaceæ. It grows in Western Himalayas from Nepal to Kumaon at an altitude of 3-4000 ft. and is commonly cultivated in gardens as an ornamental plant.

The bulbs of this species were obtained from the Chandra Nursery, Sikkim, and grown in sand and garden soil respectively. After a few months when the bulbs were transplanted an interesting formation of vegetative buds on the scales was observed.

The usual method of vegetative propagation well known in bulbs is bud formation in the axils of the scale leaves. In this particular species besides such propagation, small buds were also formed on the scale leaves on their edges, the inner and the outer surfaces (Figs. 1, 2 & 3). A single scale leaf sometimes produced as many as three such buds (Fig. 4). These made their appearance as small papillæ consisting of two overlapping opposite scale leaves. Later, however, they assumed the form of normal bulbs.



In an experiment a portion of the stem disc was cut and grown separately. It was observed that the innermost scale leaf formed a bud in the manner described above and when this scale leaf was removed the scale next to it behaved in a similar fashion. It is apparent that the scale leaves possess an inherent character for the production of vegetative buds. When, however, the scale leaves were separated from the stem disc and put on soil they failed to produce these buds.

Botany Department, P. KACHROO.
E-Punjab University,
Amritsar,
May 25, 1949.

A NOTE ON THE MICRO-ORGANISMS PRESENT IN DATE-PALM JUICE (*SENDHI*)

IN the year 1928 M. Damodaran has done work on "The fermentation of Toddy and an account of the micro-organisms producing it",[1] while later in 1939 V. S. Basrur and M. Qureshi[2] have done extensive work on the Date-Palm juice (*sendhi*) confining their attention to analysis only. The present note deals with the microscopic examination of fresh and fermented juice of *Phœnix Sylovestris* Roxb.

Samples of *sendhi* were obtained with the help of the Excise Department for our investigations. Possible precautions were taken

while collecting the *sendhi* to prevent extraneous micro-organisms getting into the liquid. The micro-organisms in the fresh juice were cultured on the *sendhi*-agar media. An examination of a number of isolated colonies under the microscope led us to suspect five kinds of organisms, which represent distinct species and these were later cultured by fractional plate cultures on *sendhi*-agar media. External morphology and nature of vegetation was carefully studied on streak cultures of *sendhi*-agar media and glucose-agar media. In the fermented *sendhi* samples however, in addition to the above suspected four micro-organisms mycoderma species was also found.

To identify the above micro-organisms, the cultural and the biochemical characters of each were studied and are described below. (For the identification of the micro-organisms, *The Yeast* by Guilliermond was consulted.[3])

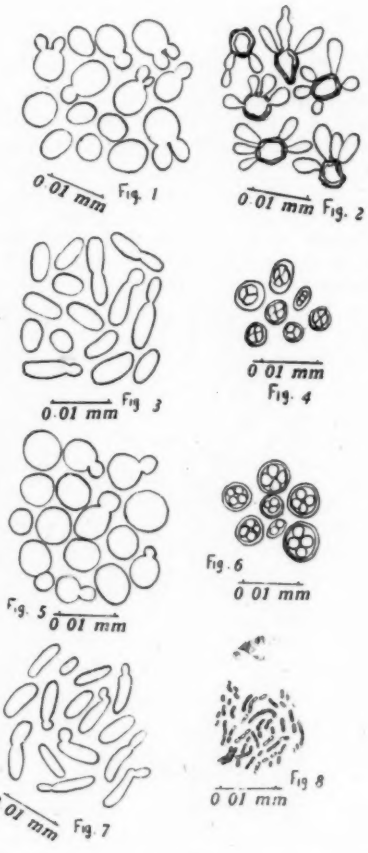
Description of the Organisms:—

1. *Yeast A*. The colonies are club-shaped with depression in the middle and are smooth, glistening and white in colour. Streak cultures are smooth with broadly wavy margin. Multiple budding is often adopted as shown in Fig. 1. The cell form is predominantly spherical in young cultures. Durable cells are formed, and budding takes place giving rise to elongated cells as shown in Fig. 2. The thermal death point is 51-52° C. This organism is identified as "Yeast-like *Saccharomyces cerevisiæ*".

2. *Yeast B*. The colonies are concentrically zoned and appear dry and powdery on the surface. Streak cultures develop flat, brown, spreading colonies. The cells are usually elongated as shown in Fig. 3. Scum is formed with growth ascending on glass wall. Four spores are formed in a cell as shown in Fig 4. Thermal death point is 53-54° C. This organism is identified as *Pichia Radaisii*.

3. *Yeast C*. The colonies are white, pasty and with a surface formed of fine raised portions. Budding is of simple type. The cell form is predominantly spherical as shown in Fig. 5. Four spores are formed as shown in Fig. 6. Thermal death point is 52-53° C. This organism is identified as *Saccharomyces cerevisiæ*.

4. *Yeast D*. The colonies are usually round, white and convex. Superficial vegetation is formed on the nutrient liquid. Cells are oblong, elongated and somewhat elliptical. Budding occurs from end on shoulders as shown in Fig. 7. Thermal death point is 52-53° C. The organism is identified as *Mycoderma cerevisiæ*.



5. *Bacteria*. The colonies are smooth, grey and glistening. Surface growth was observed after 48 hours, with a tendency to ascend at the edges. Deposit at the bottom is scanty, and slight turbidity is produced. The bacteria consists of short rods and are ellipsoidal in form. They occur singly and in pairs as shown in Fig. 8. This bacteria has many characters of Acetobacter acetii described by Jezdink Tosie and Thomas Kamedy Walker.[4]

To study the amount of growth and production of alcohol, the method described by F. G. Walter[5] was followed. The results are shown in the table along with pH values.

No.	Description	Original pH	pH after incubation for 72 hrs.	Amount of growth per 100 gm. of glucose	Amount of alcohol by vol. per 100 c.c. of 3% glucose sol.
1	*Mycoderma cerevisiæ*	6·0	3·0	17·1	nil
2	*Saccharomyces cerevisiæ*	6·0	3·0	7·7	1·72
3	Yeast-like *Saccharomyces cerevisiæ*	6·0	3·0	5·5	0·57
4	*Pichia Radaisii*	6·0	4·0	6·7	0·13

Our thanks are due to Dr. M. Qureshi under whose able guidance this work has been carried out, and also our thanks are due to Dr. S. Husain Zaheer, Director, Central Laboratories for Scientific and Industrial Research, for kindly permitting us to publish the note.

Hyderabad, Deccan, MOHAN BABU NAIDU.
June 12, 1949. J. LAKSHMIKANTHAM.

1. Damodaran, M., "The fermentation of Toddy and an account of the micro-organisms producing it," *Jour. Ind. Ins. Sci.*, 1928, **11**, 63. 2. Basrur, V. S., and Qureshi, M., "Investigations on Palm Juice—Part I. Analysis of fresh and fermented juice," *Jour. Osmania Univ.*, 1939, **7**. 3. Allexandre Guilliermond, *The Yeast*, 1920 (John Wiley & Sons, New York). 4. Jezdink Tosio and Thomas Kameiy Walker, "Acetobacter Acetii," *Jour. Soc. Chem. Ind.*, June 1946, **65**. 5. Walter, F. G, *The Manufacture of Compressed Yeast* (1940, Chapman & Hall, Ltd., 11 Henrietta Street, W.C. 2, London).

PROLIFERATION OF SPIKELETS IN *PENNISETUM POLYSTACHYUM*, SCHULT.

ARBER (1934) observed proliferation of the spikelets of *Arrhenatherum avenaceum*, Beauv., *Festuca ovina*, L., *Phleum pratense*, L., *Poa alpina*, L., *P. vivipara*, L. and in some bamboos. Nielson (1941) has recorded such proliferation in *Avena sativa* L., *Bromus inermis*, Leyss., *B. purgans* L., *Festuca obtusa*, Spreng., *Phleum pratense*, L. and *Panicum virgatum*, L. Ganguly (1936), Reeves and Stansel (1940) have recorded maize spikelets proliferating into vegetative shoots and the latter authors have also found Teosinte (*Euchlæna mexicana*, Schrad.) showing similar phenomenon. Karper (1936) and Sankara Ayyar (1942) have described the proliferation in Sorghum spikelets. A similar case was noted in Thin Napier (*Pennisetum polystachyum* Schult.) at the Rice Research Station at Tirurkuppam, Chingleput District, Madras, and this is being recorded here.

The normal inflorescence of *Pennisetum polystachyum* is a spike-like cylindric panicle (Figs. 1 and 2) brownish-yellow

FIGS. 1 & 2. Normal and proliferated inflorescence compared

and about a centimetre wide exclusive of the bristles of the involucre. The involucres, sub-sessile with about 30 bristles to each involucre. The spikelets usually solitary (rarely in twos), sessile; within the involucre, lower glume often suppressed, upper as long as the spikelet, thinly membranous, 5-nerved. Florets two, the lower empty or staminate, the upper, bisexual. Lower lemma, like the upper glume, 3-toothed at apex; palea subequal similar to the lemma or sometimes absent. Upper lemma chartaceous shining; palea similar, subequal.

The inflorescences with the proliferation of the spikelets could be easily made out

in the field by their bigger size and green colour. A detailed study of the inflorescence revealed that practically all the spikelets have been uniformly transformed into leafy structures.

The involucre surrounding each spikelet has not undergone any change (Figs. 3 & 4)

FIG. 3. A portion of the indorescence with the spikelets prolifierated

FIG. 4. A single prolifierated spikelet. The involucre of bristles remains unchanged

while the spikelet alone has become proliferated. The proliferated spikelet gives a general appearance of a seedling (Fig. 4). The lower glume, which is often suppressed in the normal spikelet, is seen prominently, much elongated hyaline and thinly nerved. The upper glume is more than double the length of the lower, greenish, prominently nerved and hairy. The lemmas and paleas have developed into normal leaves with distinct blades, leaf-sheaths and the characteristic ligules of the fringe of hairs. This is of interest as the two lower glumes do not show this differentiation.

The present case of proliferation was noted in two clumps out of a small 5-cent plot cultivated with Thin Napier for fodder, from which a number of cuttings had already been taken. While it is difficult to explain the causes for this phenomenon of proliferation of spikelets, it may be pointed out that Karper (1936), Nielson (1941), Reeves and Stansel (1940) are of opinion that proliferations are due to environmental factors. Arber (1934) records two classes of proliferations, one brought about by environment and the other by chromosomal and hereditary causes.

C. RAJASEKHARA MUDALIAR.
D. DANIEL SUNDARARAJ.
Madras Herbarium,
Agricultural College, Coimbatore,
June 15, 1949.

Arber, A., *The Gramineæ*, Univ. Press, Cambridge, 1934, 385-93. 2. Ganguly, B. D., *Curr. Sc.*, 1936, **5**, 302-03. 3. Karper, R. E., *J. Hered.*, 1936, **27**, 183-85. 4. Nielson, E. L., *Bot. Gaz.*, 1941, **103**, 177-31. 5. Reeves, R. G. and Stansel, R. H., *Amer. J. Bot.*, 1940, **27**, 27-30; 6. Sankara Ayyar, M. A., *Madras Agrl. Jl.*, 1942, **30**, 416-19.

RAIN OF PRAWNS IN SIAM

I HAPPENED to meet Mr. Spencer Leech, the representative of Winget Limited, Rochester, Kent, England, last week at Dakpather, Dehradun District, where a Hydro-electric dam is under construction. In the course of conversation he mentioned to me a rain of prawns which occurred in Siam when he was a prisoner of war in the Japanese Camp at Damagan near Kanchanbour in the month of October 1944. I am aware of the literature relating to fish brought down by rains in India and outside but this is the first time I have heard of a shower of live prawns and the information seems to be perfectly authentic and was given to me by an eye witness. One evening towards the end of the monsoon in October (the exact date Mr. Leech does not remember) just before sundown there was a heavy shower of rain. A large number of live prawns came down with the rain over the entire camp and could have been easily collected in basketfuls. The size of the prawns was about 2 to 3 inches some of them had long chealate legs. He says that the camp was far away

from the sea but there was a lake within 8 miles of the camp where military planes are reported to have landed troops. The temperature at the time of rain was not particularly cold. I am told that there were persons interested in butterfly and orchid collections in the camp and therefore it is not unlikely that an account of this unusual occurrence has already been published. If so, I shall be obliged if any one who has heard or read of this occurrence will kindly let me know about it.

Dept. of Fisheries, U.P. B. SUNDARA RAJ.
Lucknow,
July 22, 1949.

ANTI-HISTAMINE ACTIVITY OF SUBSTITUTED BENZHYDRYL AMINES

RECENTLY, the discovery of benadryl has led many workers to study the anti-histamine activity of allied dialkyl amino-alkyl benzhydryl ethers.[1] In the present work, a number of substituted benzhydryl amine hydrochlorides have been tested for their anti-histamine property.

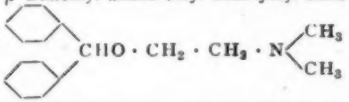
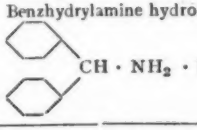
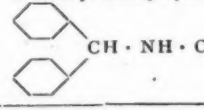
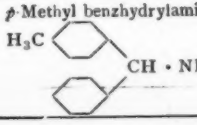
Method.—Anti-histamine activity was tested on the isolated *ileal* strip of a guinea-pig as follows: 0·1 mg. of histamine was added to the bath containing 60 c.c. of Tyrode's solution. It was allowed to act till the maximum height of contraction was reached. Then the histamine was washed out. Every time, the bath was emptied in order to wash out histamine or any drug, it was filled again with 60 c.c. of fresh Tyrode.

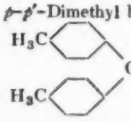
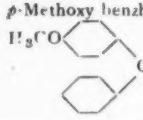
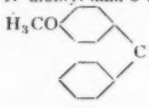
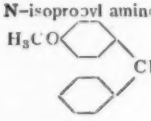
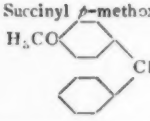
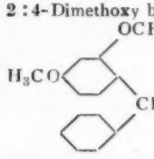
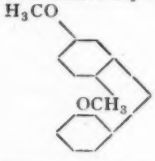
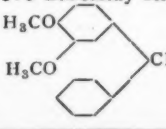
In this way, three consecutive equal responses were first obtained. These were used as the standard of the maximum response of the particular strip to the given dose of histamine. Next the compound under trial was added to the bath. At the end of ten minutes, 0·1 mg. of histamine was added to the same bath. When the maximum height of contraction was reached the compound and the histamine were washed out. Thereafter, every ten minutes, 0·1 mg. of histamine was added to the bath, till the height of contraction was equal to the original. This was taken as the duration of the anti-histamine activity of the compound.

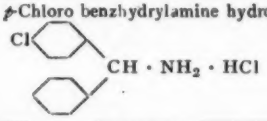
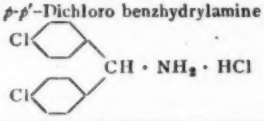
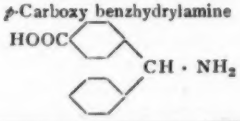
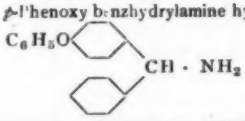
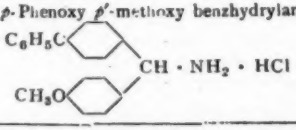
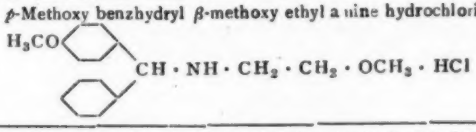
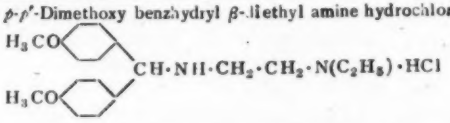
Benadryl has been taken as the standard for comparision.

Results of the work done so far are tabulated below:—

Anti-histamine Activity

No.	Compound Name and structural formula	Quantity added (mg.)	Duration of activity (minutes)
1	Benadryl β-Dimethyl amino ethyl benzhydryl ether hydrochloride 	0·1	30
2	Benzhydrylamine hydrochloride 	0·5	20
3	N *n*-hexyl benzhydrylamine hydrochloride 	0·1	less than 10
4	*p*-Methyl benzhydrylamine hydrochloride 	0·1	20

No.	Compound Name and structural formula	Quantity added (mg.)	Duration of activity (minutes)
5	*p-p'*-Dimethyl benzhydrylamine hydrochloride 	0·5	About 20
6	*p*-Methoxy benzhydrylamine hydrochloride 	0·1	less than 20
7	N-diethyl amino ethyl 4 methoxy benzhydryl ether hydrochloride 	0·1	less than 20
8	N-isopropyl amino *p*-methoxy benzhydryl ether hydrochloride 	0·1	40
9	Succinyl *p*-methoxy benzhydrylamine 	0·5	less than 20
10	2 : 4-Dimethoxy benzhydrylamine hydrochloride 	0·1	About 20
11	3 : 6-Dimethoxy benzhydrylamine hydrochloride 	1·0	40
12	4 : 5-Dimethoxy benzhydrylamine hydrochloride 	1·0	20

13	*p*-Chloro benzhydrylamine hydrochloride 	0·5	About 20
14	*p*-*p*′-Dichloro benzhydrylamine hydrochloride 	0·5	20
15	*p*-Carboxy benzhydrylamine 	0·1	less than 10
16	*p*-Phenoxy benzhydrylamine hydrochloride 	0·1	60
17	*p*-Phenoxy *p*′-methoxy benzhydrylamine hydrochloride 	0·1	50
18	*p*-Methoxy benzhydryl *β*-methoxy ethyl amine hydrochloride 	0·1	less than 10
19	*p*-*p*′-Dimethoxy benzhydryl *β*-diethyl amine hydrochloride 	0·5	20

From the above table it is clear that the following compounds are worth further investigation:—Nos. 8, 16 and 17.

Further work on the above compounds and a few more is in progress.

Our thanks are due to Dr. B. B. Dikshit, the Principal of the College who guided us throughout the work and to Prof. B. V. Bhide from S. P. College who supplied the compounds to us.

(Mrs.) Ranita Aiman.
Dept. of Pharmacology, M. B. Gharpure.
B. J. Medical College, Poona,
July 11, 1949.

1. Fitzgibbon, *J.A.C.S.*, 1948, **70**, 387.

PROCESSES OF SEPARATION INVOLVING DIALYSIS

In a continuous dialysing unit involving a number of stages the operation is counter current, and the colloidal solution containing crystalloids, and water enter at the opposite ends of the system. Each stage will contain a semipermeable membrane between two cells into one of which flows the colloidal solution to be dialysed and into the other flows water for the removal of crystalloids. Such a process is analogous to multicontact processes like distillation, extraction, etc., and is sketched in Fig. 1.

Nomenclature.

G: mols of colloid flowing in the system per unit time, on a crystalloid-free basis.

L: mols of water flowing in the system per unit time, on a crystalloid-free basis.

Y: mols of crystalloid per mol of crystalloid-free colloid, in the colloidal system.

X: mols of crystalloid per mol of crystalloid-free water, in the water stream.

Subscripts:—1 refers to rich end streams and 2 refers to lean end streams.

Taking a crystalloid balance across a differential section of the unit shown in dotted lines, in Fig. 1,

$$G.dY = L.dX \qquad (1)$$

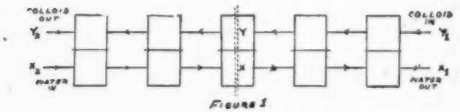


FIGURE 1.

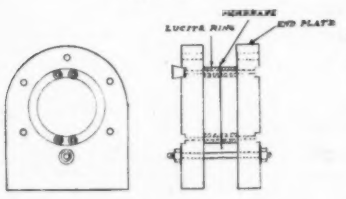


FIGURE 2.

Integrating equation (1) between the variable compositions X and Y, and the terminal compositions X_1 and Y_1, we have, on the assumption that G and L are steady,

$$G\int_{Y}^{Y_1} dY = L\int_{X}^{X_1} dX$$

$$\therefore \quad Y - Y_1 = \frac{L}{G}(X - X_1) \qquad (2)$$

Equation (2) defines the operating line that relates the composition of the colloidal stream that enters any stage and the composition of the water stream leaving the same stage. If the equation of the equilibrium line relating Y to X is known then it is possible to determine the number of theoretical stages required for the separation of crystalloid from a colloid by dialysis, by the stepwise method, provided the material balance of the system can be established. Further if the over-all membrane efficiency is known the actual number of stages required for the process can be calculated. To determine over-all membrane efficiencies experimentally it would be necessary to set up a unit containing a known number of stages and dialyse known solutions such that Y_1, Y_2, X_1, X_2, L and G are all known. If the equilibrium data are available then the theoretical number of stages may be calculated by the stepwise method. The over-all membrance efficiency is simply the ratio of the theoretical number of stages to the actual number of stages.

The author has made attempts to obtain equilibrium (Y—X) data on the system albumin-water-sodium chloride, using cellophane membrane (du Pont, No. 600) stretched between two lucite rings which were components of a laboratory dialyser made by Brosites Machine Co., of New York, (details of which are provided in the *Chemical Engineering Catalog*, 1947-48, page 372 Reinhold Publishing Corporation, New York) fitted up with lucite end plates as sketched in Fig. 2. By means of orifices provided in the end plates the spaces within the rings could be filled with known solutions. One was filled with a known solution of albumin prepared by saturating blood albumin (supplied by Fischer Scientific Co., Pittsburgh, Pa.) in distilled water, filtering, and adding a known weight of NaCl to a known volume of solution. The other was filled with water. The assembled unit was stored away in a constant temperature enclosure maintained at 70° F. The solutions were analysed at the end of 24 hours, and duplicates were run and analysed at the end of 48 hours and 72 hours until constant values were obtained. The NaCl solution was analysed by argentometry while the NaCl in the presence of albumin was calculated by difference, knowing the amount of NaCl present in the colloidal solution and the amount that was present in the water compartment. The following results were obtained:

Weight fraction of NaCl in colloidal solution	Weight fraction of NaCl in water
0·00199	0·00202
·00572	·00598
·00954	·00980

The work could not be continued owing to total destruction of the laboratory by a fire accident. The author wishes to thank Dr. James Coull, Professor and Head of Department of Chemical Engineering, University of Pittsburgh, Pittsburgh, Pa., for his interest in the work and the University of Pittsburgh for providing apparatus and facilities for work. Correspondence on the work is invited.

Poona 5, S. L. SASTRY.

July 6, 1949.

GESTATION IN THE ORIENTAL VAMPIRES

BATS, which generally bring forth only one young at birth, have asymmetrical development of the uterine cornua. Species of bats in which details of pregnancy are available, show that gestation generally occurs in the right side of the female genitalia. The findings of Vogt[1] and Duval[2] in *Vespertilio murinus* (now called *Myotis myotis*); Courrier[3] in *Miniopterus schreibersi;* Baker and Bird[4] in *Miniopterus australis;* Mathews[5] in *Miniopterus dasythrix* and Sherman[6] in *Tadarida cynocephala* support this view. My observations on *Rhinolophus rouxi* (Temn.) and *Tadarida tragata* (Dobs.) add two more instances to this category.

It appears as if this asymmetry has developed from a condition in which both the uterine cornua and the ovaries were functional. In *Pipistrellus pipistrellus,* Deansley and Warwick[7] recorded 70 per cent. of the pregnancies in the right uterine cornu, 25 per cent. in the left and 5 per cent. in both. Guthrie and Jeffers,[8] and Wimsatt[9] described in *Myotis lucifugus* ova coming as frequently from the left ovary as from the right, but with pregnancies limited to the right side.

An instance of unilateral degeneration was found by Mathews[10] in *Rhinolophus hipposideros minutus.* In this species the left uterine cornu is considerably smaller, and appears to be correlated with the functional atrophy of the left ovary which does not produce mature ova. Consequently the pregnancies are limited to the right side. It appears fortuitous which horn of the uterus becomes functional.

My observations on *Lyroderma lyra lyra* (Geof.) and *Megaderma spasma* (L.) the two Oriental Vampires of the family Megadermidæ are interesting in this connection. Immature females in both the above forms have symmetrical uterine cornua. With the attainment of sexual maturity the rapid enlargement of the left uterine cornu results in a distinct asymmetry. Sections show that only the left ovary is functional. A collection of these forms over a period of five years reveals that all the pregnancies are restricted to the left uterine cornu.

The findings of Mathews[5] in *Cardioderma cor* (family Megadermidæ), revealed that pregnancies filled both uterine cornua but with the placenta attached to the left pole of the uterus suggesting that the development must have started in the left uterine cornu. He also recorded in *Nycteris luteola* (family Nycteridæ) four pregnancies in the right uterine cornu and seven in the left showing a higher percentage in the latter.

In the families Megadermidæ and Nycteridæ there is a tendency for the left side of the female genitalia to be the functional one. The cause for this asymmetry is not clear.

My thanks are due to Dr. L. S. Ramaswami, D.Sc., Professor of Zoology, Central College, Bangalore, for encouragement and for a discussion of this problem.

Dept. of Zoology, P. A. RAMAKRISHNA.
First Grade College,
Tumkur,
August 15, 1949.

1. Vogt, C., *Assoc. Franc. pour l'Avanc des Sci.*, 1881, **10**, 355. 2. Duval, M., *Journ. Anat. et Physiol.*, 1895, **31**, 93. 3. Courrier, R., *Arch. de Biol.*, 1927, **37**, 173. 4. Baker, J. R., and Bird, T. F., *Journ. Linn. Soc. Zool.*, 1936, **40**, 143. 5. Mathews, L. Harrison, *Proc. Zool. Soc. Lond.*, 1942, **111**, B. 289. 6. Sherman, H. B., *Journ. Mamm.*, 1937, **18**, 176. 7. Deansley, R., and Warwick, T., *Proc. Zool. Soc. Lond.*, 1939, **109**, A. 8. Guthrie, Mary J., and Jeffers, K. R., *Anat. Rec.*, 1938, **71**, 477. 9. Wimsatt, W. A., *Amer. Journ. Anat.*, 1944, **74**, 129. 10. Mathews, L. Harrison, *Trans. Zool. Soc. Lond.*, 1937, **23**, 224.

Dr. J. N. MUKHERJEE

DR. J. N. MUKHERJEE, D.Sc., F.N.I., Director, Indian Agricultural Research Institute, New Delhi, has proceeded to U. S. A. as a member of the Indian Delegation to attend the United Nations Conference on the Conservation and Utilization of Resources to be held at Lake Success, from 17th August to 6th September 1949. He has been invited by the Secretary-General, U.N.O., to preside over the Land Section Meeting of the United Nations Scientific Conference.

After attending the Conference at Lake Success on his way back he will attend the meeting of the General Assembly of the International Council of Scientific Unions to be held at Copenhagen, from 14th to 16th September 1949.

REVIEWS

Advances in Enzymology, Vol. VIII. Edited by F. F. Nord. (Interscience Publishers Inc., New) York, 1948. Pp. ix+538, Price $ 8·00.

The eighth volume of this internationally well-known Annual contains critical reviews on ten different topics contributed by authors whose own contributions to their respective fields have been both large and substantial. This happy circumstance imparts to the discussions a "living touch" which is both illuminating and inspiring. The review on the functioning of the cytoplasm by Ludwik Monne deals with the advances made on the structure and the function of the cytoplasm during the last decade. The author has made a valuable contribution towards a clarification of well-established facts and valuable hypotheses. The second article pertains primarily to a discussion of the "two parallel and independent series of investigations, which together have contributed largely to a more modern and objective, although still woefully incomplete, understanding of the actual nature of complement". In the third article, J. P. Greenstein has presented a critical review of a group of comparatively little known but physiologically significant enzymes, the dehydropeptidases. I. L. Chaikoff and C. Enteman in their review on "anti-liver factor of the pancreas" have advanced convincing evidence of an yet unidentified anti-fatty liver factor associated with the pancreas. Alkaloid Biogenesis is the subject of a fascinating discussion by Ray F. Dawson in the light of the recent gene-enzyme-linked syntheses demonstrated by Beadle and Tatum in Neurospora. The discussion on the functional rôle of alkaloids in the physiological economy of the plant is suggestive.

Cellulose which is the most abundant organic compound occurring in Nature, has been the subject of numerous investigations directed towards its chemurgical exploitation. Nord and Vitucci have presented a critical review pertaining to a microbiological approach to this problem. Lignin which is invariably and intimately associated with most of the naturally occurring celluloses has also been considered and the authors have presented experimental evidence to show that an enzymatically formed methylated aromatic compound might serve as an intermediary between carbohydrate degradation and lignification.

Other reviews include Synthesis of Lipids by Kleinzeller, the Biochemistry of Fatty Acid Catabolism by F. L. Breusch, Lipoxidase and the Auto-oxidation of unsaturated Fatty acids by Sune Bergström and Ralph T. Holman and a fascinating contribution by E. Albert Zeller on the Enzymes of Snake Venoms and their Biological Significance.

Editor Nord who is the founder and guiding spirit of this series of volumes, has been successful in securing for this series an international status; the present volume contains 5 articles from the U.S.A., 2 from Sweden, 1 each from Czechoslovakia, Turkey and Switzerland. This is a volume which will commend itself to a wide circle of investigators interested in a critical appraisal of the progress of biological chemistry in its most comprehensive sense.

Chromatography. By Harold G. Cassidy and others. *Annal of the New York Academy of Sciences*, Vol. XLIX. Pp. 141-326, 1948. Price $ 2,75.

Chromatography, first discovered by Tswett in 1906, has proved itself in recent years to constitute a powerful and extensively applicable analytical tool. With its aid, compounds considered as single entities have shown themselves to be mixtures and have been resolved into their individual constituents. The method has been employed for checking the homogeneity of a compound and for establishing its identity or non-identity with another sample by a mixed chromatogram test (*cf.* mixed melting point test).

Harold G. Cassidy, the consulting editor, prefacing the bunch of contributions says that "it was felt profitable to examine the state of our knowledge regarding chromatography, and especially to make it possible for workers using one method of adsorption analysis to come together with those using other methods, so that all methods might become more widely known. It was hoped that, through such a meeting, the chromatographic tool might become further sharpened and the realm of its proper use redefined". At the conference, 14 papers have been presented including the introductory and concluding remarks by the consulting editor. The history, scope and methods of chromatography have been presented by Zechmeister, in whose hands

the method attained a substantial stage of development. Henry C. Thomas has presented "a review of pertinent parts of the equilibrium theory" and has given a mathematical treatment of single solute chromatography for the two simplest reasonable mechanisms of adsorption considered as a kinetic process. Stig Claesson has described the experimental set-up for chromatographic adsorption analysis developed by Tiselius and his co-workers. The ingenious and elegant "partition chromatography" developed by Martin and Synge, using filter paper, has been described by Martin while the starch column chromatography which makes use of the same partition principle is described by Moore and Stein. Paper strips handle only microgram quantities of the material whereas columns handle milligrams.

A review of fractionation of mixtures by foam formation is presented by Shedlovsky, a promising technique which involves the participation of mobile surfaces and one which has hardly been investigated. Applezweig has presented a very useful paper on "Ion-exchange Adsorbents as laboratory tools" and an equally useful contribution has been made by Deitz on "the surface areas of some solid adsorbents of possible use in chromatography". Other contributions include Systematic Quantitative Chromatography by Schroeder, Fractionation and Analysis of Hydrocarbons by Adsorption by Mair, Stereochemistry and Chromatography by Zechmeister and Chromatography in the Streptomycin Problem by Peck.

The volume represents a very stimulating contribution to the subject of chromatography, which is being, at the moment, extensively employed as fruitful method of analysis.

High Molecular Weight Organic Compounds: Frontiers in Chemistry, Vol 7. Edited by R. E. Burk and O. Grummitt. (Interscience Publishers Inc. N.Y.), 1949. Pp. vi + 330, Price 5·50 dollars.

This is a new addition to the now well-known series sponsored by the Western Reserve University. A vast amount of work in recent years has been with synthetic high polymers, with an emphasis that has practically flooded out the work that is still needed and being done on the natural polymers: proteins, cellulose, starches and the pentosans. This tendency is reflected also in the volume under review. Cellulose finds only the briefest reference and only proteins find a place. The other two types are non-existent so far as the current volume goes.

The first two reviews by Dr. Mark give a lucid account of the work carried out in the Brooklyn Polytechnic on polymerisation in suspension and emulsion as well as the use of osmometric and viscometric methods in polymer investigations. The experimental details presented, as well as the analytic treatment of the different aspects of the problem will be found particularly useful by newcomers to the field. The term Ac_2 in page 80 is obviously a misprint unless Bc_2 in the next line is an error for Bc_4^2. The contribution of Dr. Fisher is a highly condensed one on Elastomers and if it is intended for a student certainly requires elaboration. The only contribution in the volume on a natural polymer is that of Dr. Edsall on proteins. We have here a critical account of the different lines of investigation suggestive of further work in the subject in every section in a field which remains "a quest that will call for ingenuity, skill, and imagination of the highest order". Condensation polymers and phenoplasts are dealt with respectively by Drs. Flory and Carswell. These are quite in line with the rest of the volume in providing a useful critical review.

Even though the field of high molecular weight organic compounds is not fully covered, the volume will be a useful addition to a library for advanced students and the price is quite moderate for the contents.

S. V. ANANTAKRISHNAN.

Recent Advances in Anrlytical Chemistry: Frontiers in Chemistry, Vol. 7. Edited By Burk and Grummitt. (Interscience Publishers Inc., N. Y.), 1949. Pp. viii + 200. Price 4·50 $.

The volume is the latest addition to the series under the same editorship and the title will be welcomed by those interested in chemical analysis. Seven reviews are presented in the volume and, looking at the title one is surprised to find that Chromatography in which we see a good deal of work done during the last few years finds no place.

The opening review by Kolthoff gives a bird's eye-view of polarography. Two chapters on the use of organic reagents in inorganic analysis follow. The nature of the topics makes cataloguing an essental part of the review but one regrets the absence of critical treatment. The greater part of the first article on the subject deals with material which cannot by any means be termed recent. Nor does one see from the contributions what one might consider an abnormal emphasis on colour reactions using organic reagents that tend to use dispersion agents even where precipitates

are formed, in order to use a colorimetric method of estimation, though this happens to be the case. The use of dithizone in estimations of lead or of anthranilic acid in estimations of zinc find no reference. The contribution is none the less useful in giving indications of procedure for trying out a new reagent in analytical work. Infra-red spectroscopy is becoming increasingly important as an analytical tool and the contribution by Beeck is full of useful information. The longest monograph in the volume is the one on electron microscopy. The actual application to analyses does not find any detailed treatment but this is probably in the nature of the subject. To one not conversant with the intricacies of work in this field, the contribution is an excellent appetiser. Rossini treats the study of hydrocarbons with old tools in "the new dress of greater accuracy, greater precision and greater efficiency" but the reader can get little information useful to him on the details of these changes in experimental technique from the rather poor photographs on pp. 158 and 172. We have, however, some compensation in having useful information, found only in journals not readily available in this country. Worid War II has brought into the forefront as an analytical tool an instrument that was available in few laboratories before that date, *viz.*, the mass spectrograph. This has played an important part in recent work in the analysis of complex mixtures of gases, and vapours and the concluding article appropriately deals with this topic.

The volume under review is on the whole mixed fare that will nevertheless find a place in the library of any one in interested in analytic work.

S. V. ANANTAKISHNAN.

Surface Active Agents. By Anthony M. Schwartz and James W. Perry. Interscience Publishers Inc., New York and Interscience Publishers Ltd., London, 1949. Pp. xi + 579 Price $ 10·00.

This book deals with the achievements of the last three decades in the newly developed field of surface-active agents. The processes for synthesising and manufacturing surface-active agents are systematically described. The physicochemical surface and bulk properties as the gross effects associated with the solutions of surface-active agents have been dealt with. The applications to the different industries such as textiles, cosmetics, pharmaceutical, metal working, paints and lacquers, leather, paper, etc., are discussed in detail The treatment is in general comprehensive though a reference to the theory of contact angles, mechanism of wetting action, effects of surface-active agents on acid-base indicators and the work on the spreading of surface-active agents on aqueous surfaces would have rendered it even more complete. An up-to-date alphabetical list of commercial surface-active agents, their nature and uses could have been included with advantage.

The presentation of subject-matter and the get-up are very good. There are hardly any errors of any kind and by way of an exception one may point out that on p. 279 line 32, wherein the words "more" and "less" are to be interchanged in order to get the correct sense. This book contains much useful information and isvaluable to the technologists and scientists who wish to get posted with the information in the field of surface-active agents.

K. S. GURURAJA DOSS

Fieldbook of Natural History. By E. Laurence Palmer. Whittlesey House (McGraw Hill Book Co. New York.) 1949. Pp. x + 664 with 2,000 text-illustrations. $7·00.

This is the fourth publication in the well-known Whittlesey House Field Guide series, addressed to American readers and students of field sciences. The present work by Prof. Palmer aims at providing a ready work of reference on objects of natural history that one encounters in every day life. As stated by the author in his preface it is not a text-book in any science nor a manual for the identification of objects considered in any of the sciences. It is a field guide which persons who take some interest in their natural surroundings could consult and obtain information in a form that is non-technical, condensed and aided by illustrations. Such a work can never be exhaustive as the material has to be restricted in scope; in general, the author has attempted "to choose those things found most commonly in an unmodified or still identifiable form in the field, stream or wood lot, in the grocery or fruit store, or behind the kitchen sink".

The material is arranged in sections dealing with astronomy, the mineral kingdom, and the plant and animal kingdoms. The first two subjects occupy only a small portion of the book but these sections are valuable owing to a series of charts on the astronomical side and numerous monochromes with notes for identification in the pages devoted to minerals.

The plant life is dealt with in about 300 pages, closely following and indicating the taxonomic sequence and with accounts of chosen examples under each natural order. The majority of examples dealt with are from the North American flora but reference may be found to many plants of economic importance not found in America. The animal kingdom is dealt with in the next three hundred pages. The same procedure is followed in both the sections; each topic is illustrated at the top of the page, with the description given below in clear graphic style giving means of identification, distribution, features of structure and natural history, and economic importance. There is also an index which facilitates reference. The value of the work to non-American readers lies in the notes relating to species of economic importance, both plant and animal, distributed all over the world and information on which is not readily available in a single book, but the reader should be prepared to find several omissions of items of special interest to him. One may, however, always turn over the pages of this beautifully printed and profusely illustrated volume with pleasure and profit.

N. K. P.

Rinderpest Vaccines—Their Production and Use in the Field. (Food and Agricultural Organization of the United Nations, Washington, U. S. A., March 1949). Pp. 71. Price One Dollar.

Rinderpest is a widespread disease of cattle in Africa, Asia and Far East, and is responsible for the death of at least 2 million head of cattle with a constant threat of the spread of the disease to regions of the world where it is not prevalent at present. It causes considerable reduction in the world supply of milk and meat, and what is more serious, in the destruction of animals owned by farmers and used primarily for the Agriculture of the land. In spite of the magnitude of this economic loss there was no concerted and uniform measure for the eradication or even mitigation of this scourge. The prophylactic vaccines which are in use are not of uniform standard regarding potency and immunising quality. The method of production of vaccine and its use in the field varied in different countries and there is no absolute proof that the vaccine which was used in the field was of the desired potency in all cases and gave sufficient protection to the herds. In the vaccination against small-pox ever since Jenner's discovery development was so rapid that a more or less uniform standard of vaccine lymph was introduced in every country and vaccination programme was enforced by legislation so that considerable reduction was effected in the incidence and severity of small-pox. Similar efforts are necessary in the eradication of this terrible disease of Rinderpest.

In the stress of the post-war food scarcity the F. A. O. of the U. N. has interested itself in the problem to adopt adequate measures of control at international level. The present report is based on the meeting of the F. A. O. in co-operation with the British colonial office at Nairobi. At the meeting held between 28th October to 1st November 1948, 22 countries and territories participated in discussing method of controlling Rinderpest and unanimously adopted certain conclusions in the eradication, vaccines, etc. They considered the merits and defects of various types of vaccination.

(1) Serum virus simultaneous immunization.
(2) Inactivated virus-tissue vaccination.
(3) Goat virus vaccine.
(4) Lapinized virus-vaccine.
(5) Avianized virus-vaccine.

This last one was used with great success in China causing less reaction than any other attenuated virus vaccine and no deaths.

Many advantages were claimed in favour of this vaccine although more research was needed on the aspect of occasional difficulty experienced in adapting the virus to egg embryos. This vaccine can be attenuated to any desired point of effectiveness and safety to be used on hypersuceptible animals. Further work is needed to assure uniform keeping quality of the vaccine. The cost of this vaccine is very low. These points are sufficient for extended trial of this vaccine. It is expected that an intense world wide programme of control measures will result in the ultimate mitigation if not eradication of this deadly disease of cattle.

K. P. Menon.

The Physical Chemistry of Process Metallurgy.

The publication No. 4 in the series of discussions of the Faraday Society is a collection of papers read at the discussions held under the auspices of the Faraday Society from 23rd Sept. to 25th Sept. 1948. Distinguished physical chemists and metallurgists took part in the discussion.

The discussions cover three aspects of Process Metallurgy, *viz*, (1) Metallic solutions, (2) Roasting and Reduction processes, (3) Slags and Refining processes.

The introductory address by Sir Andrew McCance is followed by a paper on "The Physico-Chemical Principles in Process Metallurgy" by Sir Charles F. Goodeve. The author deals with the general principles of physical chemistry and the two important approaches in physical chemistry: the kinetic and the thermodynamic. The kinetic approach which starts with a picture of the intimate molecular mechanism of a chemical change, followed by mathematical deduction to allow comparison with experimental results, has been applied with success to gaseous reactions and perhaps is capable of general application. The thermodynamic approach has the desirable quantitative exactitude. He refers to the possible application in study of slag refining processes deoxidation of steel, etc.

The brilliant introduction is followed by several papers relating to the study of metallic solutions. Some outstanding contributions have been made. the paper on "Activities in liquid metallic solutions" by John Chipman dealing with the concept of activity, the thermodynamic equations involving it and the methods of determining activities, viz., vapour pressure, E. M. F. measurements phase diagrams, chemical equilibrium, is a useful contribution. He introduces the concept of semi-regular solutions and describes its usefulness in metals.

The second paper by J. A. Kitchener and collaborators deals with "The activity of sulphur in liquid iron: the influence of carbon." A thermodynamic treatment of experimental results on the interaction of sulphur with iron is given. The influence of carbon in desulphurisation is studied and the authors conclude that sulphur activity is doubled approximately by saturation of the melt with carbon at 1560° C.

John Lumsden in the paper on "Thermodynamics of lead-zinc alloys" deals with lead-zinc phase diagram activities of Zn in the system. He concludes that the percentage of Pb. in zinc produced at each stage of the distillation is independant of the amount of Pb. present in the charge, provided there is sufficient lead to saturate the gas through the cycle of operations. The temperature and hence the lead content of zinc condensed increases as the distillation proceeds.

R. M. Barrer examines some equilibrium and kinetic aspects of interstitial solid solutions, conditions for formation of such phases in his paper on "Aspects of Gas Metal Equilibrium, interstitial solution and diffusion." An attempt has been made to interpret the hardness and inertness of some of these phases in terms of the theory of metallic bond due to Pauling.

In the next paper on "Kinetics of nitrogen evolution from an iron interstitial alloy" by Charles Goodeve and K. H. Jack, the rates of denitriding of Σ-iron nitride in vacuum, N_2, CO, and H_2 have been determined with X-ray studies.

Details and important features of construction of molybdenum furnaces are given in the paper on "Notes on the experimental technique of some physico-chemical measurements between 1000-2000° C." by J. A. Kitchener and collaborators.

In the last paper in the series on "Elimination of thermal diffusion error in studies of gas metal equilibrium" by Mina Dastur and John Chipman, the errors are said to be eliminated by the use of pre-heating or inert gas.

The series is followed by a general discussion.

The second section contains eleven papers. The important paper is on "The general survey of roasting and reduction processes" by C. W. Dannatt and H. J. T. Ellingham. Charts giving standard free energy of formation ($-\Delta G^\circ$) of oxides and sulphides: variation with temperature will be useful according to the authors in the study of mechanisms and rate of reaction in extraction processes.

An examination of some properties of the diagrams of complex equilibria constructed by plotting of inverse of the absolute temperature as abscissa and log. of equilibrium oxygen pressures as ordinate has been made by Pourbaix and collaborator in "Graphical study of metallurgical equilibrium".

The use of voltaic cells of the Daniell type with molten salts has been discussed in the paper on "Studies in the thermodynamics of metallurgical reduction processes by electrochemical methods" by B. A. Rose and collaborators.

The next paper on "The primary reactions in roasting and reduction processes" by Anderson summarises some evidence derived from studies of semi-conduction in oxide and sulphide systems.

Peretti discusses the use of X-ray methods of study and cylindrical briquettes in the paper titled "A new method for studying the mechanism of roasting reactions". The same author deals with the defects of bottom blow converter in "An analysis of the converting of copper matte."

S. E. Woods examines the possibility of "The reduction of oxides of iron as a diffusion-controlled reaction" in his paper.

Pure metal crystallites cannot start dissociation of CO but it requires the presence of an interface like Ni-NiO or Fe-Fe_3C or the prior formation of carbon nuclei. This is explained with precise measurements by A. Juliard and collaborators in "Kinetic study of the disassociation of CO accompanying the reduction of metallic oxides".

L. M. Pidgeon discusses the reduction of dolomite by ferro-silicon at 1100—1200 C in his paper on "The vapour pressure of Mg in the thermal reduction of MgO by ferro silicon". The vapour pressure of Mg has been found to be much higher than was usually accepted. CaF_2 catalyses but has no effect on the equilibrium vapour pressure.

The last two papers are by Gross and collaborators, the first titled "Some equilibria involving Al monohalides" the second "The reduction of ZnS by Fe".

The series is followed by a general discussion.

In the third series there are seven papers. The interesting paper by Richardson on "The constitution of thermodynamic of liquid slags," covers the present state of knowledge of the structure and thermodynamic theory of solutions and the methods of determination of the activities from liquid immiscibility and from melting point diagrams. Solidification curves of binary silicate systems are plotted. These curves together with data on the stability of silicates and some potentiometric determinations give an idea of the change of activities.

The ionic mechanism of conduction process in the systems is substantiated in the paper on "Electrical conductivity of silicate melts: the systems containing Ca, Mn, and Al," by J. O. M. Bockris and collaborators.

The concept of molecular species is examined in relation to the properties of non-stoichiometric phases and in relation to the use of law of mass action in steel making equilibria, by G. M. Willis in his paper on "The constitution of phases at high temperature in relation to their thermodynamic properties".

In the paper on "Equilibrium relationships in systems containing iron oxide and their bearing on the problem of the constitution of liquid open hearth slags" P. Murray and J. White consider the above two aspects of the constitution of slags.

That the carbon content of the bath is the factor which has the greatest influence upon the oxygen content during the refining period and Mn has no influence, are the conclusions mentioned by Fornander in his paper "The behavior of oxygen in liquid steels during the refining period in the basic open hearth furnace".

The last paper on "The physical chemistry of sulphur removal in steel making" by Carter deals with role of different oxides present in free state in desulphurisation. The author concludes that their ability is the same. If in a combined state the ability is diminished. Mn in the metal can have no effect on the final equilibrium distribution except in so far as it may increase the activity of sulphur in the metal phase.

A general discussion follows this series.

The publication is a valuable addition to any Metallurgical library.

J. B.

Organic Reagents used in Gravimetric and Volumetric Analysis. By John F. Flagg. (Interscience Publishers Inc. New York), 1948. Pp. xiv + 299.

The book under review is a welcome addition to the existing books on chemical analysis and fills a definite gap in the literature on inorganic quantitative analysis, though some aspects of the subject have been covered by other books also.

The book has been divided into two sections, the first part deals with the theoretical aspects of the subject and gives a short resume of the organic chemistry involved in the use of organic reagents. The physical and chemical properties of the compounds with which the analyst deals have been discussed. The section concludes with a chapter on special techniques that are required in analysis with organic reagents. The second section is devoted to a detailed discussion of the various important organic precipitants and gives a sufficiently complete picture of the behaviour, use and further scope of the reagents.

The book describes mainly the macro-methods of analysis, and a reasonably complete bibliorgaphy of the micro-methods has also been included.

A glance at the various organic reagents will reveal that most of them are of the type that form chelate complexes. A book like the present one will invoke considerable interest in the minds of organic chemists to test other similar compounds or to synthesise substances

which may ultimately prove to be more useful in analysis.

The appendix embodying the (i) table XXX presenting the drying temperatures and conversion factors of the precipitates formed of the inorganic elements with the organic reagents, and (ii) table XXXI indicating the various organic reagents used for each element, makes the book very handy and convenient for immediate reference.

The general get-up of the book is good and the present volume will undoubtedly find a place in all the modern libraries.

P. C. GUHA.

Human Ancestry from a Genetical Point of View. By Professor R. Ruggles Gates. (Cambridge, Mass. Harvard University Press; London: Oxford University Press, 1948). Pp. xvi+422, 27 Plates. 42*s*. net.

Fossil evidence for the ancestry of Man was scanty in the days of Darwin, but the publication of his *Descent of Man* in 1871 was followed everywhere by vigorous search for the so-called missing links. The number of discoveries throwing light on human ancestry has been indeed large during the last seven decades, but in several cases the material was either too fragmentary or the stratigraphic information too flimsy. Interpretational difficulties due to personal equation have also been great. If, for example, in a discussion of the status of the Piltdown woman's brain, Keith could regard it as "comparable to modern man" and Elliot Smith, on the other hand could put it down as "the most primitive and most simian brain", common sense tells us that several of our seemingly learned writings on human evolution are in the pre-logical mode. Very large segments of the world including those which, on theoretical grounds, should be regarded as areas of characterisation of early Hominids, have not been properly searched for bone relics. Taxonomic studies on living Man have also not produced satisfactory results to clear the existing confusion. We do not yet know enough of human genetics, human biochemistry, etc., to be in a position for any one authoritatively to analyse and say what primary races or species of man constitute the highly mixed geographical groups of any part of the world. It is under these circumstances that Prof. Ruggles Gates has ventured on the present review of the problems from his own special angle.

The main thesis of the book is that the concept of Linnaeus that all living types of man belong to one species should be "repudiated" and instead of regarding them as sub-species, the main races such as the Caucasian, Mongolian, Australian, Negroid and Bushmen should be elevated to the rank of species. These species sprang from three different stems, in three different parts of the world, but since all the three sprang from a common primitive miocene stock they have been undergoing parallel evolution. In other words, the very large number of points of similarity between the different "species" of man is due to parallel evolution over a long period and the points of difference due to new mutations. In "splitting" the species *Homo sapiens*, Gates seems to be simplifying problems too much; he overlooks the many difficulties which confront the practical worker in the field. As matters stand at present, the diagnosis of human subspecies is indeed difficult and confused, but if these subspecies, on the suggestion of Gates, are to be elevated as species, it should be possible to give clearer criteria for them than for mere varieties. No helpful suggestions are given on this important question. The subjective feelings of Gates on this culturally vital, but scientifically not so important, question of human races are countered by the views of others, equally competent, among whom is included Darwin.

The valuable part of the book is the discussion of the palæontological data concerning man. No important discovery till 1946 has been left out. At p. 56 is given a scheme of primate evolution which summarises the author's views. *H. caucasius*, *H. africanus*, Hottentot, and Bushman evolved from *H. capensis* (Boskop), which in its turn came from Africanthropus (Neanderthal); *Sinanthropus* gave rise to *H. mongoloideus* including variety *americanus*; and *Pithecanthropus* gave rise to *H. australicus*. This scheme is quite different from those given by Clark and Weidenreich and in places less convincing, but as Hooton says in his Foreword, "So I would not urge upon the reader of this useful book, *Human Ancestry*, that he accept its contents as eternal verities".

There are a few misprints, Riedschoten (p. 154), Aijappan (p. 356). At p. 153, Eickstedt is quoted with approval ignoring the criticism of Dr. Guha. At p. 133 there is a statement to the effect that the Nordics are the only people who combine dolicocephaly with hypsicephaly, but the reviewer's work on the Nayadis summarised at p. 357 shows that these two characters are combined in that tribe.

A. AIYAPPAN

SOME METHODS OF PURIFICATION AND INDUSTRIALLY IMPORTANT REACTIONS OF *p*-CYMENE

JAMES VERGHESE

THIS review deals with some methods of purification and industrially important reactions of p-Cymene (i) not discussed in the previous paper.[58]

PURIFICATION

The chemical industry needs pure (i) for its syntheses and processes. Out of the crude (i) obtained from liquid and vapour phase dehydrogenation of terpenes, from sulfite turpentine and essential oils, it is extremely difficult to isolate (i) by fractional distillation. Other hydrocarbons also distil over along with (i) necessitating expensive additional steps.[1,2]

Careful distillation followed by treatment with sulfuric acid is stated to be the best for refining (i).[4] Essentially the unsaturated impurities are thus destroyed but the ejection of the isopropyl chain from (i) resulting in a high yield (65%) of toluene is also reported.[59] Various concentrations and quantity of acid are recommended.[2,3,5,6,8,14]

Wheeler[7] observed that concentrated acid slightly sulphonated (i). Methods based on complete sulphonation are also used.[9,10,11,12]

Digestion with metalic sodium,[5,13,14,15,16,17,19] phosphoric anhydride,[13] oxidation with Beckmann's reagent[17] or potassium permanganate,[5,14,17,18,21] fractional distillation under reduced pressure[13,14,19], bromination,[14] and dehydrogenation over a catalyst,[20] are some of the aids to purification.

Patents are granted for refining by treatment with condensing agents, *e.g*, zinc chloride,[21,22,23] and gaseous hydrochloric acid.[24]

Extraction of (i) with fuming sulfuric acid containing 15% sulfur trioxide[25,26] and liquid sulfur dioxide,[27] chromatographic separation[28,29] of *p*- and *o*-Cymenes followed by fractional crystallisation of their sulfonamides,[28,30,31] are the latest improvements to the methods of purification.

Pure *p*-Cymene should display no unsaturation.[3]

REACTIONS

Action of aluminium chloride

Anschutz[32] heated (i) with one-third its weight of aluminium chloride, and obtained a liquid reaction product containing toluene. Treatment with 10% by weight of aluminium chloride, according to Moore and Egloff,[33] yielded 0·8% benzene, 14·3% toluene, 7% xylenes, 28·5% unchanged (i), and 48·4% unidentified jelly-like mass. In presence of hydrochloric acid, McKee[34] obtained toluene, propane and a small quantity of tar.

The combined action of aluminium chloride and benzene on (i)[35,36,37] with the formation of isopropyl benzene and toluene afforded a true reversal of Friedel-Crafts reaction, and suggested a striking possibility of utilising (i). Is opropyl benzene is a remarkable fuel (aviation-) blending agent.[39] It is a raw material for the production of benzoic acid.[37] Methods have been developed to dehydrogenate it to α-methyl styrene[38] which can be isolated in a state of purity.[41] 80% decomposition of this hydrocarbon almost exclusively into propylene and benzene is effected at 500° over a SiO_2—ZrO_2—Al_2O_3 catalyst.[40]

Schorger[17,42] carried out several series of experiments from 65-100° with varying amounts of aluminium chloride and showed that there are formed diisopropyl, benzene, toluene (40%), *m*-xylene and *l*-methyl-3,5-diisopropyl benzene. At room temperature, according to Lacourt,[43] no gas was evolved during 10 days; benzene, toluene, xylene, 1,3,5-diisopropyl toluene, unchanged (i), and a high boiling residue were isolated.

Friedel-Crafts Reaction

Equimolecular amounts of aluminium chloride (i) and acetyl chloride gave *p*-acetyl toluene, unchanged (i), an intermediate ketonic fraction (b.p. 126-132·5°/16 mm., n_D^{18} 1·5228), acetyl-p-Cymene, a fraction of b.p. 138-145°/16 mm., n_D^{18} = 1·512, and a brown viscous residue. The best yield of acetyl-p-Cymene (97%) is obtained by dropping an equimolecular mixture of (i) and acetyl chloride into aluminium chloride in carbon disulfide at 10°. Oxidation with nitric acid (d. 1·15) indicated that the keto group is ortho to methyl.[43]

Acetyl-p-Cymene is likely to find numerous industrial uses. Typical constants are: d_0^0 : 0·9864 : d_{20}^{20} : 0·9654 ; n_D^{20} : 1·51849, boiling range 124·2—125·2°/12 mm.

Tertiary-butyl-p-Cymene

Extensive decomposition of (i) resulted on interaction with aluminium chloride and tert-butyl chloride, whilst with tert-butyl alcohol and con. sulfuric acid at -10-0°, tertiary-butyl-p-Cymene (1:2:4 $C_6H_2Pr^{\beta}CMe_3$) was formed in good yields. This on nitration (fuming HNO_3, <0°) gave 3:5 dinitro derivative possessing intense musk odour.[44]

Pressure Cracking

The density of (i) hardly changed on cracking in an Fe-autoclave for 3 hours at 425°. Volatile products were less than 10%. The gases contained 1·1% unsaturated hydrocarbons, 2·3% carbon monoxide, 68·5% hydrogen and 28·1% methyl hydrocarbons. About 1% toluene and 3% xylene were obtained.[45]

Action of Nitrosyl-Sulfuric Acid

Puranen and Ehrnrooth[41] describe specific processes for the production of a hydrocarbon $C_{20}H_{24}$, by treating (i) at a low temperature with a solution of nitrosyl-sulfuric acid in con. sulfuric acid. The nitrosyl-sulfuric acid may be formed *in situ*. The heavy hydrocarbon formed is amenable to nitration, chlorination or sulfonation, and is useful for the manufacture of explosives and dyes.

Hydrogenation

In the gas phase (i) is hydrogenated to *p*-menthane (75%) over nickel at 180°.[47] Kobe and Vittone[48] accomplished the liquid phase hydrogenation at 220° under pressure in the presence of 1% nickel.

p-Menthane is an excellent solvent, saturated, and with extremely narrow boiling range.[1] The latest developments in the *p*-menthane industry are its oxidation to acidic compounds,[1,49] and to a solvent, wetting and disinfectant composition consisting largely of tertiary alcohols and ketones,[50] dehydrogenation to 4-α-dimethyl styrene,[51] and the utilisation of its cu-mercaptide as a stabiliser for lubricating oils used in internal combustion engines.[52]

Sulfonation

The 2- and 3-Cymene sulfonic acids are important intermediates in the manufacture of carvacrol, thymol and various dyes, and are useful for hydrolysis of fats.[53]

Sulfonation of (i) with sulfuric acid at various temperatures and also with 15% oleum had been carefully studied.[54,55,56] Temperature is the principal factor in determining the relative quantities of the two isomers produced.[54] 15·6% of 3-sulfonic acid is obtained by the action of sulfuric acid at 100° with 1:3 ratio of (i) to acid.[54] Temperatures above 100° and sulfates, *e.g.*, $CuSO_4$, $HgSO_4$ are unfavourable.[54] At 0° with oleum, the yield of this isomer dropped to 2·5% and a 90% Ba-2-sulfonate was recovered.[54]

Fevre[55] sulfonated (i) with sulfuric acid containing 15% SO_3 and obtained the following yields of Ba-2-sulfonate: (*a*) 0-10°, 87-91%; (*b*) 50-80°, 49·5—53% and (*c*) 90-100°, 49%.

Substitution in (i) (1 mol.) with sulfuric acid (2 mols. d. 1·84) at 50-75° and 100° for 4 hours gave 78-90% 2-isomer and 20% 3-isomer.[56]

Isolation of the 2-sulfonic acid as the magnesium salt has been patented.[57]

I desire warmly to thank Prof. Dr. R. B. Sandin, of Alberta University, Edmonton, Canada, for his invaluable suggestions and encouragement in preparing this review.

---

1. Palmer, *Ind. Eng. Chem.*, 1942, **34**, 1028. 2. Sondhi, Bhushan, Gulati and Joshi, *J. Indian Chem. Soc. (Ind. and News Ed.)*, 1947, **10**, Nos. 1 and 2, 17. 3. Guha, Roy and Paul, *J. Indian Inst. Sci.*, 1944, **28A**, 1. 4. Hellstrom, *Papierfabr*, 1914, **12**, 1025. 5. Boedtker, *J. Pharm. Chim.*, 192), (8), **9**, 417. 6. Bretscher, *Physikal Z.*, 1932, **32**, 765. 7. Wheeler, *J. Amer. Chem. Soc.*, 1920, **42**, 1842. 8. Wheeler and Smithey, *ibid.*, 1921, **43**, 2611. 9. Perkin, *J. Chem. Soc.*, 1896, **69**, 1191. 10. Henser, Zeh and Aschen, *Z. angew. Chem.*, 1923, **36**, 37. 11. Muckenberger, Ger. Pat. 1934, 597,972. 12. Ipatieff and Pines (to Universal Oil Products Co.), U.S. Pat. 1946, 2,394,691. 13. Bogert and Tuttle, *J. Amer. Chem. Soc.*, 1916, **38**, 1349. 14. Ritcher and Wolff, *Ber.*, 193), **63**, 1721. 15. Mann, Montonna and Larian, *Ind. Eng. Chem.*, 1936, **28**, 598. 16. Fevre, *J. Chem. Soc.*, 1933, 980. 17. Schorger, *J. Amer. Chem. Soc.*, 1917, **39**, 2671. 18. Austerweil and Peufaillit, Brit. Pat., 1923, 206,848. 19. Koening, *Papierfabr. Tech. Wiss. Teil*, 1925, **23**, 501. 20. Littmann (to Hercules Powder Co.), U.S. Pat. 1946. 2,400, 012. 21. British and Foreign Chemical Producers Ltd., Brit. Pat. 1919, 142,738. 22. Stalman, U.S. Pat., 1922, 1433,666. 23. Koch and Dubois, Belg. Pat., 1931, 383,373. 24. Metalleges, Ger. Pat., 1928, 494,005. 25. Ipatieff, *et al*, *J. Org. Chem.*, 1947, **12**, 34. 26. —, and Pines, *J. Amer. Chem. Soc.*, 1945, **67**, 1226. 27. —, —, and Savoy, *ibid.*, 1947, **69**, 1948. 28. Pines, Olberg and Ipatieff, *ibid.*, 1948, **70**, 533. 29. Mair and Forziati, *J. Research Natl. Bureau Stand.*, 1941, **32**, 151, 165. 30. Huntress and Carton, *J. Amer. Chem. Soc.*, 1940, **62**, 511. 31. Huntress and Autenrieth, *ibid.*, 1941, **63**, 3446. 32. Anschtuz, Annalen, 1886, **235**, 191. 33. Moore and Egloff, *Ch. m. Met. Eng.*, 1917, **17**, 61. 34. McKee, U.S. Pa 1917, 1, 244, 444. 35. Boedtker and Halse, *Bull. Soc. Chim.*, 1916, **4**, **19**, 444. 33. Wheeler, *Ind. Eng. Chem.*, 1918, **10**, No. 5, 359. 37. "Spruce Turpentine", *ibid.*, 1918, **10**, No. I, 4. 38. The Distillers Co., Ltd., Stanley, Brit. Pat., 1939, 514,587; Stanley and Salt, Brit. Pat.,

1943, 555,000; U.S. Pat. 1944. 2,342, 980; Balandin and Marukyan, *Compt. rend. acad. sci., U.R.S.S.*, 1945, **48**, 482. 39. Alden (to Philips Petroleum Co.), U.S. Pat., 1948, 2,409, 156; Rendel, *Aero Digest*, 1946, **53**, No. 6, 105, 155. 40. Greensfelder, Voge and Good, *Ind. Eng. Chem.*, 1945, **37**, 1168. 41. Slotterbeck and Morell (to Standard Oil Development Co.), U.S. Pat., 1947, 2, 432,802. 42. Schorger, *Ind. Eng. Chem.*, 1918, **10**, No. 4, 258. 43. Lacourt, *Brussels Univ. Bull. Soc. Chim. Belg.*, 1929, **38**, 1. 44. Barbier, *Hel. Chim. Acta*, 1932, **15**, 592; U.S. Pat., 1932, 1, 892,128. 45. Sachanen, and Tilichev, *Ber.*, 1929, **62B**, 658. 46. Puranen and Ehrnrooth, Ger. Pat., 1935, 611, 461. 47 Sabatier and Senderens, *Compt. rend.*, 1901, **132**, 568, 1254. 48. Kobe and Vittone, *Ind. Eng. Chem.*, 1940, **32**, 775. 49. Palmer and Bibb (to Newport Industries Inc.), *U.S. Pat.*, 1942, 2, 303, 465. 50. Palmer, Bibb and McDuffe Jr. (joint inventors to the same assignee), U.S. Pat., 1942, 2,302,467. 51. Dixon (to American Cyanamid Co.), U.S. Pat., 1945, 2,376,309. 52. Fox (to E.I. du Pont d. Nemours & Co.), U.S. Pats., 1946, 2,407,265 and 2,407,266. 53. McKee and Lewis, *Chem. Met. Eng.*, 1921, **24**, 969. 54. Phillips, *J. Amer. Chem. Soc.*, 1924, **46**, 686. 55. Fevre, *J. Chem. Soc.*, 1934, 1501. 56. Kuan, *J. Chem. Soc. Japan*, 1931, **52**, 473. 57. Chem. Fab. von. Heyden A.G., (Curt Philip), Ger. Pat., 1924, 466,360. 58. Verghese, *This Journal*, 1948, **17**, 352. 59. Bergstrom, Cederquist and Trobeck, *Svensk Papperstidn*, 1945, **48**, 246.

SCIENCE NOTES AND NEWS

Engineering and Marine Exhibition in London

The organisers of the Engineering and Marine Exhibition (incorporating the Welding Exhibition), which takes place at Olympia, London, from August 25 to September 10, have already issued their official bulletin of the exhibits, from which some indication of the scope of this event may be obtained.

With the patronage and active support of the British Engineers' Association, the Society of Motor Manufacturers and Traders (Marine Section), the British Electrical and Allied Manufacturers' Association, the Institute of Welding and the British Acetylene Association, the Exhibition promises to display a representative selection of the products of these important branches of the United Kingdom industry.

Several well-known makes of oil engines for marine propulsion and auxiliary services as well as for industrial and traction purposes, will be available for inspection. One stand will be devoted to the uses and possibilities of aluminium in shipbuilding and marine engineering, whilst another firm, specialising in the manufacture of solid drawn seamless nonferrous tubes, will exhibit copper and brass tubes and fittings for a variety of uses. Other products will include transmission belting of all types, electric motor control equipment, pneumatic tools, lubricating oils and greases, electric duplicating machines as well as modern drawing office and photo print-room equipment and materials.

Complete ranges of welding equipment, accessories and electrodes will be shown in the Welding Exhibition.

A world-famous Clydeside engineering company will be showing scale models of its products. These include a luxury liner, ships' machinery, and gas turbines for use ashore. The Department of Scientific and Industrial Research and the Board of Trade will show how the Government can assist industry.

Biochemistry at Cambridge

"*NATURE*" has announced that Professor A. C. Chibnall is to shortly retire from the Sir William Dunn Chair of Biochemistry. He will be succeeded in October next by Professor F. G. Young who is holding the Chair of Biochemistry at the University College of Science in London.

International Mining Congress at Oxford

The technical progress and problems of the mining industry of the British Commonwealth were discussed at the Fourth Empire Mining and Metallurgical Congress held at Oxford recently. In the course of the discussions, Sir John Cockroft, Director of Britain's Atomic Energy Establishment, pointed out that the development of atomic energy hinges upon an adequate supply of uranium and thorium, without which all the efforts of the atomic scientists would be useless.

The search for uranium has brought into general use among prospectors the Geiger-Muller counter. One speaker told how in Canada its use had led to the discovery of uranium deposits in Ontario, Saskatchewan, the North-West territoires and British Columbia. Also, measurements of the force of gravity, of electrical conductivity and magnetic forces have been pressed into service in modern aerial surveys. Aerial photography has proved invaluable for quickly covering large areas not easily prospected on the ground; detecting devices slung beneath aircraft have been useful, especially in dealing with snow-covered territory.

Several speakers dealt with working conditions in mines and refineries. A mass of information has been collected on the effects on the human body of high temperatures, humidity, poor ventilation and other factors which affect both health and output. In consequence, it has been possible to define a limit as to what may be tolerated, and often to suggest how working conditions may be improved. Such surveys have extended even to the psychological effects of working under extreme conditions.

The Congress has made it clear that the British Commonwealth has immense mineral resources, many of which are already being worked, while thorough surveys are being made to locate the rest in regions never fully prospected. Special attention is also being given to the problem of working ores poorer than those normally accepted, which is the problem facing miners everywhere, and one in which a powerful lead is of great importance.

London Conference of E.N.T. Specialists

More than 1,300 delegates, including about 900 specialists in ear, nose and throat diseases from 39 countries, are now in London attending the Fourth International Conference of Otolaryngology. India is represented by four delegates, Dr. C. A. Amesur of Bombay, Dr. (Miss) C. M. Leelavathi of Madras, Lt.-Col. P. Papatla of Cuttack and Dr. D. Rom of Patna.

The Congress programme is packed with readings of scientific papers, with technical discussions and with visits to hospitals and clinics.

The patron of the Congress is the King, and it was opened on his behalf by the Duchess of Kent. The President is the celebrated surgeon, Mr. V. E. Negus.

By the time the Congress ends the delegates will have heard the results of clinical and research work in otolaryngology throughout the world.

New Director of the National Physical Laboratory, England

The Lord President of the Council has appointed Professor E. C. Bullard, M.A., Ph.D., F. R. S., Professor of Physics in the University of Toronto, to be Director of the National Physical Laboratory. It is expected that Professor Bullard will take up the appointment in January, 1950.

Professor Bullard will succeed Sir Charles Darwin, K.B.E., M.C., Sc.D., F.R.S.

Foodstuffs for Animal Establishments

The Government of India have agreed to the proposal by the Council of Scientific and Industrial Research for the issue of rations for rats and other animals maintained by various laboratories for biological and biochemical experiments, and accordingly arrangements are being made by the Provincial and State Governments for the issue of rations at the rate of half an ounce of cereals per rat per day, to *bonafide* research workers on applications duly forwarded by the Heads of Departments concerned.

Andhra University Award of Research Degrees in Physics

On the recommendation of the Board of Examiners consisting of:—

1. Prof. Max Born (*Chairman*), University of Edinburgh, Edinburgh (Scotland), 2. Prof. P. P. Ewald, Queen's University, Belfast, Northern Ireland, 3. Prof. J. J. Weigle, Institute of Physics, University of Geneva, Geneva, appointed to adjudicate on the thesis entitled "Studies in Some Aspects of Crystal Physics," the Snydiate of the Andhra University has resolved that Mr. D. Suryanarayana, M.Sc., be declared qualified for the degree of Doctor of Science (D.Sc.).

On the recommendation of the Board of Examiners consisting of:—

Prof. J. J. Weigle (*Chairman*), Institute of Physics, University of Geneva, Geneva, Switzerland. 2. Prof. P. P. Ewald, Department of Mathematical Physics, The Queen's University, Belfast, Northern Ireland, 3. Prof. Jean Cabannes, M.Sc., Dean of the Faculty of Sciences, Sorbonne, Rue Victor Cousin, Paris 5, appointed to adjudicate on the thesis entitled "Diffraction of Light by Ultrasonic Waves," the Syndiate has resolved that Mr. B. Ramachandra Rao, M.Sc., be declared qualified for the degree of Doctor of Science (D.Sc.).

INTERNATIONAL SCIENTIFIC AND TECHNICAL CONGRESSES

Date 1949	Subject of Conference	Organising Body	Location
Aug. 17–Sept. 6	United Nations Scientific Conference on Conservation and Utilisation of Resources	U. N. Information Centre, Russel Square House, W.C. 1	Lake Success, U.S.A.
Sept. 1-3	2nd International Congress on Electro-Encephalography	M. Baudoin, Fauculte de Medicine, University de Paris	Paris
Sept. 3-10	26th Session of International Statistical Institute	H. Campion, Esq., Central Statistical Office, Great George Street. S. W. 1.	Berne
Sept. 5-10	4th International Nourology Conference	Dr. Raymond Garcin, 19 Rue de Bourgogne, Paris 7.	Paris
Sept. 5-7	International Association for Hydraulics Structures Research		Gronoble
Sept. 5-9	Colloquium on Nuclear Physics	International Union of Pure and Applied Physics	Bale
Sept. 5-11	15th General Conference, International Union of Chemistry	Organising Committee, P. O. Box 71, Leyden, Netherlands	Amsterdam
Sept. 6-10	Conference on Low Temperature Physics	Prof. G. C. Slater, Department of Physics, Massachusetts Institute of Technology	Cambridge, Mass. U. S. A.
Sept. 9-12	Summer Meeting of British Society of Soil Science	Dr. F. W. Russell, Department of Agriculture, Oxford University	Leeds
Sept. 11-16	Colloquium on Cosmic Rays	International Union of Pure and Applied Physics	Como
Sept. 12-17	The Laurentian Hormone Conference	Chairman, 222, Maple Avenue, Shrewsbury, Mass.	Franconia, U. S. A.
Sept. 12-17	International Congress of Mechanical Engineering	Secretary of Congress, Centre de documentation de la Mecanique, 11 Avenue Hoche, Paris 8	Paris
Sept. 12-17	International Colloquium on the Absorption of Heterogeneous Kinetics	Centre National de la Recherche Scientifique, 13 Quaf Anatole France, Paris 7	University of Lyon
Sept. 14-16	General Assembly. International Council of Scientific Unions	Prof. F. J. M. Stratton, Conville and Caius Collegc, Cambridge	Copenhagen
Sept. 18-23	American Chemical Society. 116th National Meeting	American Chemical Society	Atlantic City
Sept. 19-30	4th Session of U.N.E.S.C.O. General Conference	U.N.E.S.C.O.	Paris
Sept. 19-23	Symposium on Engineering Structures	Prof. A. G. Pugsley, Merchant Venturers Technical College, Bristol 1	Colston Research Society, Bristol
Sept 29—Oct. 1 & 4	Summer Meeting of Groupement pour l'Advancement des Methods d'Analyse spectrographique des Produits Metallurgiques	G. A. M. S., I Place, St. Thomas d'Acquin, Paris 7e	Paris
Sept. (Undecided)	F.A.O. Conference on Locust Control	Food and Agriculture Organization	Central America
Oct. 1-9	International Congress of Scientists concerned with Colonial Development	Ingenieurs pour la France D'Outre-Mer et les pays Exterieurs. 11 Rue Tronchet. Paris 8e	Paris
Oct. 3-10	Autumn Meeting of Institute of Metals	Secretary, Institute of Metals, 4, Grosvenor Gardens, S. W. 1.	Paris
Oct. 17–Nov. 1	African Regional Scientific Conference	C. S. I. R., P.O. Box 395, Pretoria	Johannesburg
Oct. 23-30	22nd International Congress of Industrial Chemistry	Societe de Chimie Industrielle, 28, Rue St. Dominique, Paris 7	Barcelona
Oct. (Undecided)	F.A.O. Meeting on Control of Infestation in Stored Grain	Food and Agriculture Organization	Palmira, Colombia
Nov. 1-5	Pacific Chemical Exposition	James O. Clenyton, Research Association of California Research Corporation	San Francisco

Editor: M. Sreenivasaya, B.A., F.I.I.Sc., F.A.Sc.
992-49 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for the Current Science Association, Bangalore.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

KHETI

A monthly Hindi Journal devoted to the publication of original articles of practical interest and vital importance to the farmers, landowners, rural development workers, co-operative societies, libraries, etc. Gives most up-to-date information regarding latest developments and improvements in the fields of Agriculture and Animal Husbandry.

An ideal monthly magazine for the layman

Annual Subscription Rs. 6 Single copy As. 8

INDIAN FARMING

A Popular Monthly Magazine for the Public

Features of the Magazine include original articles of practical interest to farmers, what the scientists are doing, what's doing in all-India, you ask we answer, etc. Of special interest to farmers, landowners, rural development workers, co-operative societies, government officials, clubs, libraries and college students.

Annual Subscription Rs. 6 Single copy As. 8

INDIAN JOURNAL OF AGRICULTURAL SCIENCE

Quarterly : A journal dealing with agriculture and allied sciences. Mainly devoted to the publication of the results of research and field experiments.

INDIAN JOURNAL OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY

Quarterly: A journal dealing with Animal Husbandry and Veterinary Science and allied sciences. Mainly devoted to the publication of scientific research relating to health, nutrition and breeding of livestock.

Annual Subscription Rs. 6 Per copy Rs. 2

To be had of

MANAGER OF PUBLICATIONS
CIVIL LINES, DELHI

JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH

ANNOUNCEMENT

The schedule of advertisement charges in the **Journal of Scientific and Industrial Research** has now been raised, and the new rates come into force from **August 1949.** The revision will be without prejudice to existing contracts and will take effect after the expiry of the contracted period.

The revised rates are as follows :

	Full page	Half page	Quarter page
12 Insertions	Rs. 500	Rs. 275	Rs. 150
6 Insertions	Rs. 275	Rs. 150	Rs. 90
1 Insertion	Rs. 50	Rs. 28	Rs. 18

Advertisements in colour: (Rs. 15 extra per page per colour)

FAVOURED POSITIONS (Full page 12 insertions only)

2nd and 3rd cover pages and pages facing reading matter	Rs. 600 each
4th cover page	Rs. 750

For particulars apply to :

EDITOR
JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH
"P" Block, Raisina Road, NEW DELHI—3